# DIVISION 6
# ASPHALT BASES AND PAVEMENTS

**NOTE: The Department has developed and is continually updating a manual that addresses in detail most all asphalt related items, policies, procedures, reports, and other asphalt requirements. This manual is referred to as the HMA/QMS Asphalt Manual and is considered a part of the Specifications and this Construction Manual.**

## SECTION 600
## PRIME COAT

### 600-1 DESCRIPTION

Prime coat is a sprayed application of low-viscosity liquid asphalt to a base course of untreated material. It is the initial incorporation of asphalt onto the surface of soil or aggregate base course in preparation for the overlying pavement structure. The objectives of priming are:

1. To waterproof the surface in order to prevent surface water from penetrating the base course or subgrade material.
2. To plug voids, coat and bond loose mineral particles, and harden the surface being primed.
3. To provide temporary covers in cases of delayed pavement construction or planned stage construction.
4. To control dust.
5. To promote adherence of overlying asphalt courses or surface treatment granular bases, including both ABC and soil type bases.
6. To improve laydown and allow better compaction to be achieved on the first course of asphalt pavement placed.

Prime will be applied to the base beneath an asphalt plant-mixed pavement when required by the contract. Generally, prime is needed when a surface layer of asphalt pavement is to be placed on a non-asphaltic base. If prime is not specified in the contract when a surface layer of pavement is to be placed directly on an unstabilized soil type base, consideration should be given to adding a prime coat. Prime required by the contract should not be eliminated without the specific approval of the State Construction Engineer or his representative.

All non-asphalt bases beneath an asphalt surface treatment should be treated with a prime coat.

### 600-2 MATERIALS

This article does not list any specific brands or grades of materials; however, a particular brand or grade must be approved prior to use. A list of approved prime coat materials is maintained by the Materials & Tests Unit and may be obtained by contacting the Chemical Testing Engineer at (919) 329-4090.

All prime coat materials are now emulsified asphalts that have been pre-thinned with water. Due to the Department's concerns about the environment, the use of cut back asphalts (ones pre-thinned with a petroleum product) have been discontinued and are not included on the approved materials listing.

## 600-8 MAINTENANCE AND PROTECTION

Excess prime not absorbed into the base after 24 hours should be absorbed with blotting sand and removed from the surface.

### TECHNICIAN'S CHECKLIST
### SECTION 600
### PRIME COAT

1) Study Specifications, Plans, and Special Provisions
2) Is the prime coat material to be used on an approved list maintained by the Materials & Tests Unit?
3) Has the base material been approved for grade and superelevation?
4) Is the base clear of all objectionable material?
5) Have bridge decks, curbs, and handrails been protected from tracking or splattering?
6) Has the proper quantity of Prime Coat been spread uniformly?
7) Record in diary all conversations, observations, spot checks made, and work performed.

## SECTION 605
## TACK COAT

### 605-1 DESCRIPTION

A tack coat is the spray application of low viscosity asphalt to an existing asphalt or concrete surface to promote bond between old surfaces and the overlying pavement structure.

### 605-4 SURFACE PREPARATION

The 4 essential requirements of a good tack coat operation are:

1. The surface to be tacked must be thoroughly cleaned.
2. It must be applied at the proper rate. (See Article 605-7 for application rates and temperatures.)
3. It must uniformly cover the entire area to be resurfaced.
4. Remove grass, dirt, and other materials from the edge of the existing pavement prior to the placement of tack coat.

### 605-7 APPLICATION RATES AND TEMPERATURES

Tack coats should be applied in a thin coat and uniformly cover the entire surface, including all vertical surfaces of joints and structures. Too little tack coat can cause debonding and too much tack coat can cause slippage.

A loss of bond between HMA layers can cause crescent-shaped slippage cracks or debonding to occur, leading to reduced pavement life.

Apply only as much tack coat material as can be covered with base, intermediate, or surface course material during the next day's operation except where public traffic is being maintained.

When tack coat is required beneath an open-graded friction course, the asphalt grade and rate of application to be used on the project will be specified on the job mix formula in accordance with Section 650. Use of excessive tack coat with this type of mix can possibly contribute to excessive "bleeding" of the open-graded mix, resulting in a slick riding surface.

### 605-9 PROTECTION OF TACK COAT

If possible all traffic should be kept off the tack coat.

**TECHNICIAN'S CHECKLIST**
**SECTION 605**
**TACK COAT**

1) Study Specifications, Plans, and Special Provisions
2) Is the tack coat material to be used on an approved list maintained by the Materials & Tests Unit?
3) Is the surface to be tacked clean and dry?
4) Is the ambient temperature in the shade above 35º F?
5) Have bridge decks, and curbs been protected from tracking or splattering?
6) Are the nozzles on the distributor truck clean and able to uniformly spray the tack coat across the surface to be paved?
7) Has the initial quantity of tack coat material in the distributor been measured?
8) Has the proper rate of tack coat been spread uniformly?
9) Is the application temperature of the tack coat within the tolerances of Table 605-1?
10) Record in diary all conversations, observations, spot checks made, and work performed.

## SECTION 607
## MILLING ASPHALT PAVEMENT

### 607-1 DESCRIPTION

Milling of asphalt pavement is the process of removing the pavement at locations, depths, widths, and typical sections indicated in the contract documents or as directed by the Engineer. The work also includes removing, transporting, and disposing of the milled material and cleaning the milled pavement surface.

The milled material normally becomes the property of the Contractor unless indicated otherwise in the Special Provisions. All milled material must be disposed of by the Contractor in areas provided by him that are outside the right-of-way, except where the milled material is required to be used in the work by the Special Provisions.

There are many advantages of milling versus other pavement removal methods. The pavement can be removed relatively quickly with minimal interruption to traffic flow, and in some cases the restored pavement can be opened to traffic immediately. The removal of asphalt pavement by milling is not limited to interstate or primary highways, but may also be utilized on rural secondary routes and urban projects. This process may also be effectively utilized in spot pavement maintenance operations. The milling procedure consumes substantially less energy than other methods of pavement removal and the removed material can usually be used again without further processing in a hot recycled asphalt pavement or possibly in an aggregate base course.

Milling can correct several pavement problems while saving time and money by not having to adjust adjacent structures or geometric designs. Some problems which can be corrected by milling are rutting, washboarding, pushing, shoving, and bleeding. Milling improves the texture for bonding of additional asphalt pavements and retains guardrail heights and bridge clearances. On multi-lane highways, the distressed lane can be milled with limited inconvenience to the traveling public. Also, the desired profile and cross-sections of roadways can be restored so that drainage systems can function properly.

It is important to understand that milling (pavement removal) is a separate entity from hot mix recycled pavements. Milling may or may not be done in conjunction with the production of a recycled mixture. Also, milled pavements may or may not be overlaid with a recycled hot mix. The connection of the two is that the RAP from the milling operation may be used in a recycled mix. The purpose of milling, though, is not necessarily that of producing RAP for use in recycled pavements. The purpose(s) of milling should be that as discussed above.

### 607-2 EQUIPMENT

The Technician should always verify the equipment meets the specifications and is in good operating condition such that it will leave a reasonably smooth surface profile and texture. When the milling teeth are excessively worn, lost, broken, improperly replaced or out of adjustment, the machine will not be capable of leaving a surface free of excessive variations, ridges, and/or irregular texture.

When existing asphalt pavement is to be milled, the removal must be done by cold milling with equipment (“milling machine”) that has been designed and built exclusively for pavement milling operations and with sufficient power, traction, and stability to accurately maintain depth of cut and slope.

The milling machine must be equipped with an electronic control system which will automatically control the longitudinal profile and cross slope of the milled pavement surface through the use of either a mobile grade reference(s), an erected string line(s), joint matching shoe(s), slope control systems, or other methods or combination of approved methods. Locate the position of the grade control system such that the grade sensor is at the approximate midpoint of the mobile reference system.

## 607-3 CONSTRUCTION METHODS

The Engineer may waive the requirement for automatic grade and cross-slope controls where conditions warrant. However, the automatic controls should be used whenever possible to ensure a smooth longitudinal profile.

The Engineer may require re-milling of any area exhibiting laminations or other defects.

## 607-4 TOLERANCE

Removal of the existing pavement shall be to the depth required by the plans or Special Provisions. The Engineer may direct the Contractor to vary the depth of milling by as much as one inch. This provision is not intended to arbitrarily change the depth of milling for a full inch throughout an entire project. The intent is to allow the depth to be modified to meet the variable conditions sometimes encountered on a given project. For example, if increasing or decreasing the depth is needed to remove the existing pavement at the interface between two previously placed layers, the Engineer could direct the depth change up to one inch without a modification in the price. As stated, this provision can and should be used when necessary, but should not be abused.

When the directed depth of milling per cut is altered by the Engineer more than one inch, either the Department or the Contractor may request an adjustment in unit price under the provisions of Article 104-3.

In administering the requirements of Article 104-3, the Department gives no consideration to value of the reclaimed asphalt material due to the deletion or reduction in quantity of milling. For example, if the typical sections detail milling through an intersection and the Department determines it is in the best interest of the public to delete this milling, the contractor is barred from claiming higher costs to produce the asphalt mix due to the deletion of an anticipated amount of material to be used in a recycled asphalt mix. The Contractor should not have treated the anticipated millings as a commodity.

Incidental milling occurs when the Contractor is required by the plans to mill irregular areas and intersections or is directed to re-mill areas whose length is less than 100 feet. Measurement will be made for each cut the Contractor is directed to perform. Should the Contractor elect to make multiple cuts to achieve the final depth, no additional measurement will be made beyond the initial measurement.

**TECHNICIAN'S CHECKLIST**
**SECTION 607**
**MILLING ASPHALT PAVEMENT**

1) Study Specifications, Plans, and Special Provisions.
2) Is the milling equipment capable of accurately maintaining a consistent depth?
3) Is an automatic grade control system being used to establish the depth of milling?
4) Have all manholes, meter valves, and other obstructions been located?
5) Is the milling machine leaving a uniform and reasonably smooth surface?
6) Does the depth of milling need to be adjusted slightly (less than ±1 inch) in order to remove any thin sections of an existing pavement layer?
7) Record in diary all conversations, observations, spot checks made, and work performed.

## SECTION 609
## QUALITY MANAGEMENT SYSTEM FOR ASPHALT PAVEMENTS

### 609-1 DESCRIPTION

This section requires that all dense graded asphalt mixtures be produced, placed, and compacted in accordance with a quality control / quality assurance (QC/QA) program. This QC/QA program in North Carolina is named the hot mix asphalt quality management system (HMA/QMS). The Department has developed and is continuing to update a manual that describes in detail the policies, procedures, reports, and other requirements for the administration of this system. This manual is referred to as the HMA/QMS Asphalt Manual and is considered a part of the QMS specifications and this Construction Manual. The manual is revised on an annual basis; however, the specification and manual that are in effect at the time a contract is advertised are the ones that govern that contract unless agreed upon differently by the Contractor and the Department.

Portions of this section of the specifications contain the requirements for the certification of the asphalt field testing laboratory as well as the certification requirements for plant and roadway technicians involved in the QC/QA process. Both of these are covered in detail in the HMA/QMS Manual. Since the certification of personnel is extremely critical to the success of the program, those requirements are also covered below.

All provisions of other sections of the specifications pertaining to asphalt pavement construction will apply except as modified in Section 609. As normal, when the contract includes provisions that are different from the HMA/QMS Asphalt Manual, the Special Provisions will govern.

In addition to the HMA/QMS specification for dense graded HMA, there are several other QMS specifications for other type asphalt mixes. All of these specifications are in the form of Project Special Provisions. One version covers Open-Graded Asphalt Friction Course (OGAFC), Permeable Asphalt Drainage Course (PADC), and Ultra-Thin mixes. Another version addresses requirements for Hot-In-Place Recycled mix and one version covers all Maintenance related asphalt. For the most current version of these Special Provisions contact the Contract Standards and Development Unit by phone at (919) 707-6900 or the Pavement Construction Section at 919-707-2400.

Due to the evolving nature of the HMA/QMS specifications and procedures, Section 609 will not be discussed in detail, except for Price Adjustments and Personnel Certification Requirements contained below. The Contractor, materials suppliers, Department personnel, and others should refer to the latest edition of the HMA/QMS Asphalt Manual as noted above for more detailed information.

### PRICE ADJUSTMENTS

The HMA/QMS specification was developed with the philosophy that quality asphalt pavements be produced and constructed with full payment at the contract unit prices being provided to the Contractor.

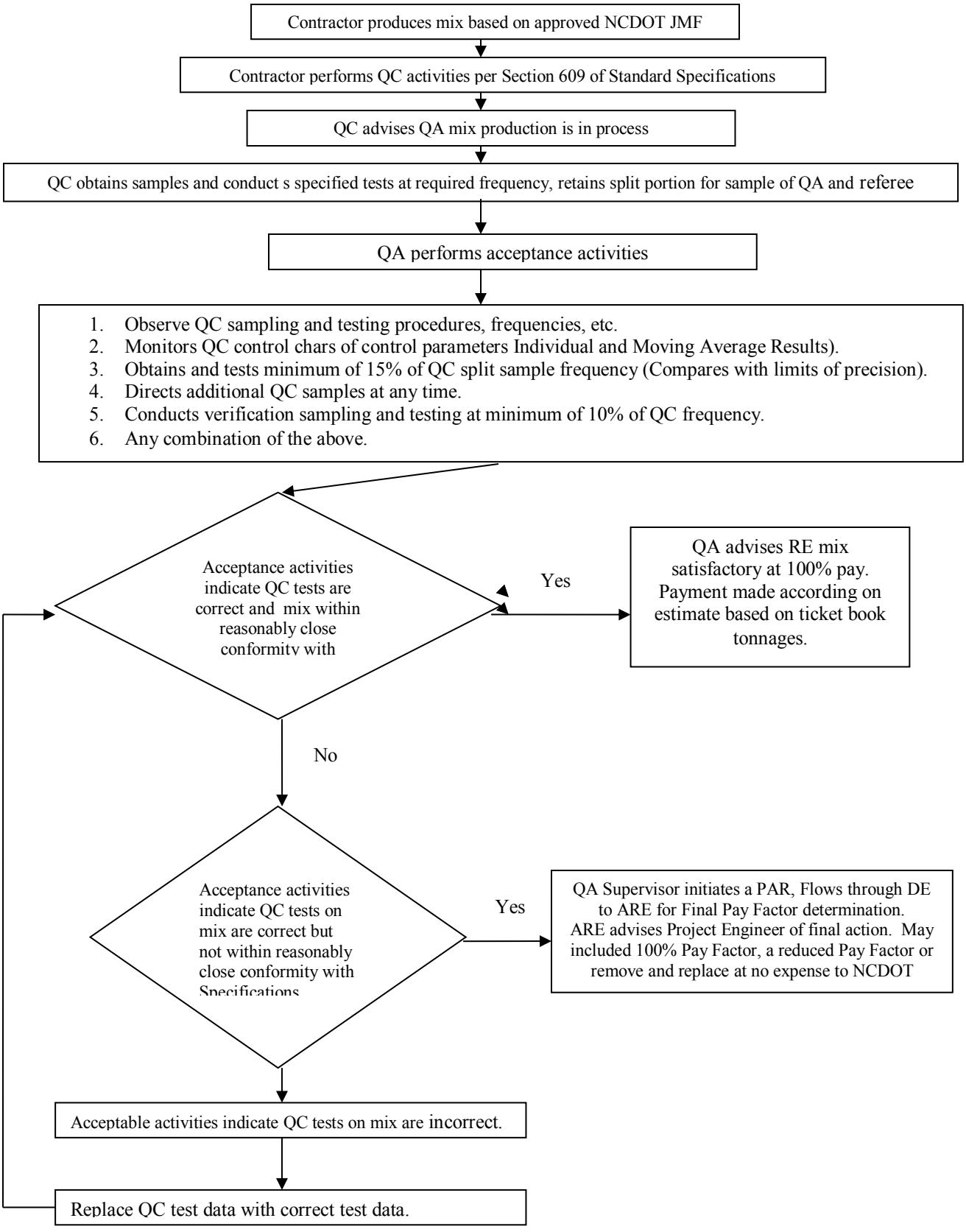
However, there may be times when the mix or pavement is deficient and does not fully comply with specification requirements. In some situations, there are clearly defined reductions that the Engineer is authorized to automatically make. There are also several situations where a decision on acceptance must be made in accordance with Article 105-3. On the next pages are two flow charts recommended for use in administering QMS price adjustments for mix and density deficiencies.

In order to make this process more uniform and our review more thorough and quick, the attached checklists of needed information have been established. Please note that there are two checklists: One for QMS projects and one for Non-QMS projects. For all future submittals for review of asphalt pavement failing test results, these checklists should be used to ensure that all needed information is furnished.

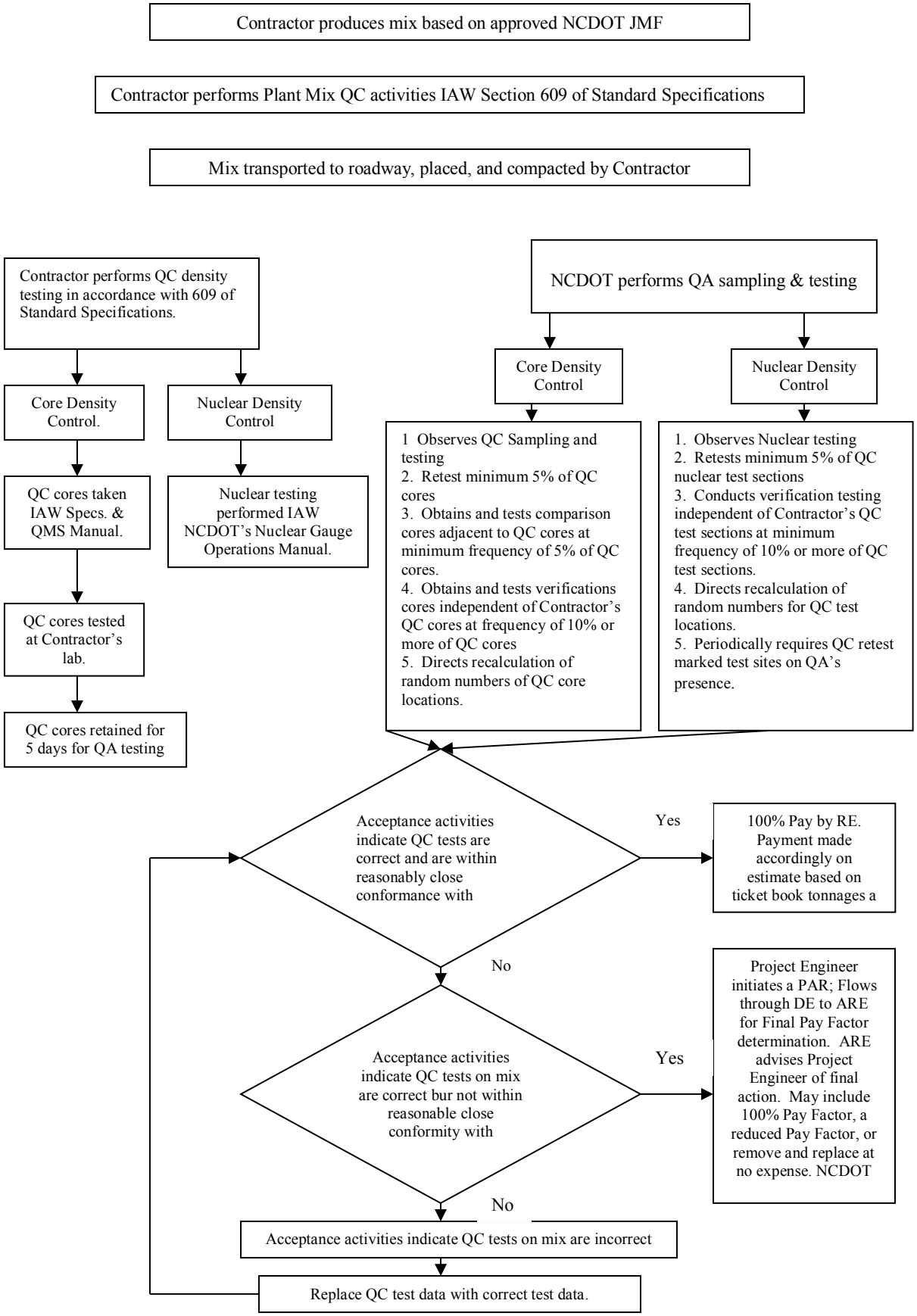
It is important that failing test results be addressed as soon as possible after occurring and not allowed to remain unresolved until after the completion of the project.

Any questions concerning the check list(s) should be directed to the Pavement Construction Engineer or any member of his staff.

## QC/QA Asphalt Mix Acceptance Procedures



# QC/QA Asphalt Density Acceptance Procedures



## NCDOT ASPHALT TECHNICIAN CERTIFICATION PROGRAM

### (A) GENERAL

The Quality Management System specification (Section 609) requires that certain asphalt Technicians be NCDOT certified. The certification of asphalt Technicians is a program by which it can be reasonably assured that both the DOT's quality assurance personnel and the Contractor's quality control personnel are knowledgeable and qualified to perform the required sampling, testing and inspection of asphalt mixtures and pavements. Certification will also include a general knowledge of the techniques and equipment used in the construction of asphalt pavements, including mix design, asphalt plant mix testing and volumetric properties, roadway placement operations, and compaction / density operations. Under the NCDOT program, a Technician may be certified in mix design techniques, plant mix sampling, plant mix testing, roadway operations, nuclear density gauge operations, or any combination of these. Certification in either area will include some overlap into the other area. For example, a certification in roadway operations will include a basic knowledge and understanding of plant procedures, etc. This is required because proficiency in one area requires some general knowledge of the overall operation.

The certification program will be operated on an ongoing basis. There will be certification classes and examinations scheduled throughout each year. In addition, there will be an ongoing "on-the-job" training program for Level I Plant and Roadway Technicians. The Department will provide applications for and maintain a master training schedule of all related classes. The appropriate contacts for the classes and applications are given at the end of Types of Certification below. The most current schedule of training classes is maintained on the Asphalt Laboratory Section's web site given in Section 609-1 above.

All certifications will generally be effective for 4 years, beginning from the date of passing the certification test, and then must be renewed prior to its' expiration. See the HMA/QMS Asphalt Manual for more specific details for certification requirements and renewal.

### (B) TYPES OF CERTIFICATIONS

Listed below are the different types of certifications related to dense graded asphalt pavements and a basic job description for each. Some certifications require a prerequisite certification before advancement to the next level of certification.

1. **QMS Roadway Technician** - A Technician trained and competent in roadway laydown, compaction, and density procedures.
2. **QMS Level I Superpave Plant Technician** - A Technician trained and competent in testing and inspection of Superpave asphalt mix at the plant site.
3. **QMS Level II Superpave Plant Technician** - A Technician trained and competent in making mix adjustments and solving Superpave asphalt mix problems.
4. **QMS Nuclear Gauge Operator** - A Technician trained and competent in the use of a nuclear density gauge in accordance with the HMA/QMS specification.
5. **Superpave Mix Design Technician** - A Technician trained and competent in the area of Superpave asphalt mix design procedures.
6. **QMS Mix Sampling Technician** – A Technician trained and competent in sampling of Superpave asphalt mix at the plant.

In addition to the above certifications, a Technician testing Hot In-Place Recycling (HIR) mix on a project must be specifically certified as a Level I HIR Plant Technician.

Certifications will generally be effective for four years beginning from the date of passing the appropriate written exam. Failure of an exam will require the person to attend the class again and retake the exam. Two consecutive failures of an exam will constitute the person having to repeat the full appropriate certification requirements before another retake of the exam is allowed. This means a repeat of the OJT requirements for either a Level I Plant Technician or a Roadway Technician. Upon satisfactory completion of all certification requirements, the Technician will be issued an appropriate certificate.

There is **no certification for the Introduction to Asphalt Pavements course.** This is a very basic asphalt course designed to provide general knowledge of both asphalt and roadway operations to personnel with little or no experience. It is a prerequisite for some of the other certifications; therefore, a "completion" certificate will be issued to verify satisfactory completion. A written exam will be given at the end of the course and will be used to judge satisfactory completion. This course is also a part of the Transportation Technician training series required for promotion to higher salary levels.

The Department's Certification Program for QMS plant and roadway Technicians is managed by the Asphalt Laboratory Section in the Materials and Tests Unit. This section will maintain a listing of all plant and roadway QMS personnel certified by NCDOT. This listing will be maintained in the Department's Highway Construction and Materials System database (HiCAMS). The Asphalt Laboratory Section may be contacted at 919-329-4060 for further instructions on how to access this information. This listing may be used to verify certification of personnel working on QMS Superpave projects.

It is required that both DOT and Contractor Nuclear Density Gauge Operators be certified through the Department's current QMS Nuclear Density Technician's Program. The Contractor's nuclear gauge operator is required to be on the project at all times when nuclear density testing is required. The DOT gauge operator will only be on the project as necessary to perform quality assurance testing. The Department's Certification Program for QMS Nuclear Gauge Technicians is managed by the Soils Engineer of the DOT M&T Unit. The Soils Engineer will maintain a listing of all certified QMS Nuclear Density Technicians and may be contacted at 919-329-4150for verification of these. This listing will also be maintained in a computer database.

The HMA/QMS Specification requires that the Contractor design his own asphalt mixes. He may do so by use of his own personnel or by hiring an approved firm to do it for him. Whichever the case, any Technician performing mix designs for use on QMS specification projects must be certified through the Department's current mix design certification program. The Asphalt Design Engineer manages this certification program. The Asphalt Design Engineer may be contacted at 919-329-4060 for verification of a Technician's mix design certification.

A flowchart of all the certification requirements is contained at the end of this section.

## (C) RENEWAL CERTIFICATION

A technician will be required to renew his certification prior to the expiration of the current certificate in effect. Requirements for renewal of certifications include attendance of the regular appropriate class and passing the written exam. A lapse in certification of more than one year may result in an applicant having to meet all prerequisite requirements for the applicable Technician certification.

## (D) LOSS OF CERTIFICATION BY SUSPENSION OR REVOCATION

All certified Technicians are subject to loss of their certification by suspension or revocation. The primary reason for the loss of a certification by either means would be the

falsifying of test results, records and/or reports. Other reasons that might lead to loss of certification include insubordination, gross negligence and apparent incompetence on the part of the technician. All reported occurrences of violations, misuse or abuse of this certification will be documented by the appropriate person(s).

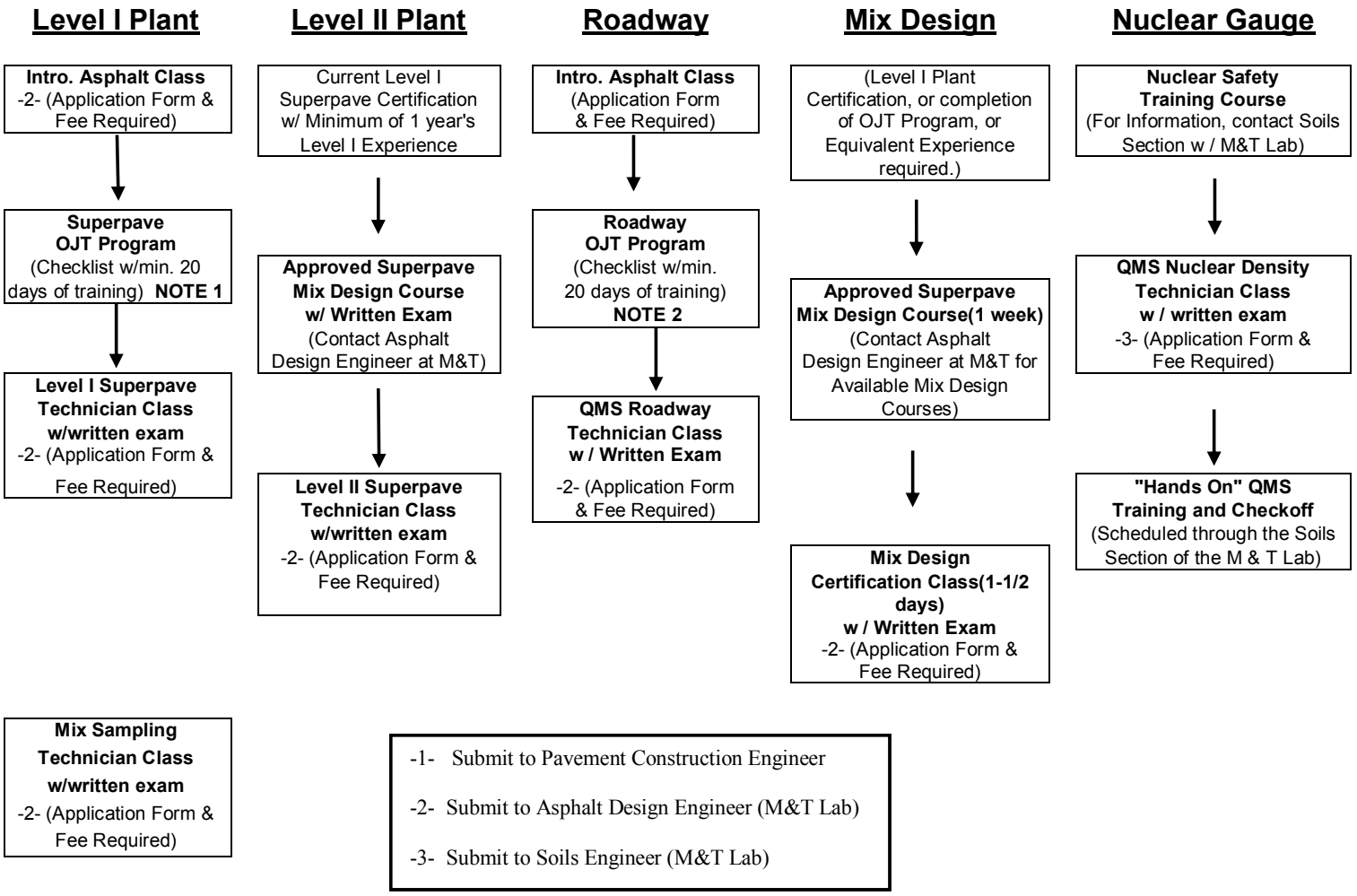
The Asphalt Design Engineer may suspend or permanently revoke any certification. Suspension or revocation of a certification will be sent by certified mail to the Technician, the Quality Control Manager and the Corporate Head of the company that employs the Technician.

A Technician has the right to appeal any adverse action which results in suspension or permanent revocation of certification by responding, in writing, to the State Materials Engineer within 10 calendar days after receiving notice of the proposed adverse action. Failure to appeal within 10 days will result in the proposed adverse action becoming effective on the date specified on the certified notice. Failure to appeal within the time specified will result in a waiver of all future appeal rights regarding the adverse action taken. The Technician will not be allowed to perform duties associated with the certification during the appeal process.

The State Materials Engineer will hear the appeal and make a decision within seven days of hearing the appeal. Decision of the State Materials Engineer shall be final and shall be made in writing to the Technician.

If a certification is temporarily suspended, the Technician must pass any applicable written examination and any proficiency examination, at the conclusion of the specified suspension period, prior to having the certification reinstated.

## 2006 NCDOT ASPHALT TECHNICIAN CERTIFICATIONS




**NOTE 1**: In lieu of the 20 day minimum training and the minimum requirements in Parts II, III and IV of the OJT Checklist, a current asphalt plant mix testing certification from another State or other approved testing agency may be substituted. In this case, a copy of the certification shall be attached to the back of the OJT checklist.
In addition, the OJT technician must perform one repetition of all requirements in Parts II, III, and IV in the presence of a certified plant technician prior to the checkoff by a final review technician. All other requirements of this OJT checklist shall be completed as specified.

**NOTE 2**: In lieu of the 20 days minimum training, either of the following may be substituted:
1) a current roadway paving certification from another state or other approved testing agency, or
2) Certification verifying a minimum of 1 year asphalt roadway paving experience from a supervisor who has direct knowledge of the applicant's roadway paving experience.
In either case, the appropriate certification shall be attached to the back of the OJT checklist and included with the class application package. All other requirements of the OJT checklist shall be completed in full as specified, including the Final Review Checkoff by an Approved Final Review Technician.

## SECTION 610
## ASPHALT PLANT MIX PAVEMENTS - GENERAL

### 610-1 DESCRIPTION

The Engineer and both QA and QC Technicians, should thoroughly review the contract to determine if there are either Standard or Project Special Provisions which would modify the Standard Specifications for that particular project. In addition, all personnel of the Department and the Contractor should become familiar with the policies, procedures, reports, and other information included in the NCDOT Hot Mix Asphalt Quality Management System Manual, hereinafter referred to as "HMA/QMS Asphalt Manual."

### 610-2 MATERIALS

See Division 10 of the Specifications for the requirements of materials referred to in the various sections of the Specifications covering the specific type of plant mix being produced and placed.

### 610-3 COMPOSITION OF MIXTURES (MIX DESIGN AND JOB MIX FORMULA)

### (A) MIX DESIGN- GENERAL

Under the HMA/QMS Program, the Contractor is required to design the asphalt mix and to obtain an approved Job Mix Formula (JMF) issued by the Department prior to beginning mix production. A mix design and proposed JMF targets for each required mix type and combination of aggregates, reclaimed materials, or other modifiers must be submitted both in writing and in electronic format to the NCDOT Asphalt Design Engineer for review and approval at least 20 days prior to start of asphalt mix production.

The mix design (MD) must be prepared in an approved mix design laboratory by a **certified mix design Technician**. The NCDOT Asphalt Design Engineer prior to preparation and submission of the mix design must approve the design laboratory. For Superpave mixes, the mix design is to be prepared in accordance with:

1. AASHTO R 35, "Standard Practice for Designing Superpave HMA" as modified by the Department,
2. recommended procedures in the Asphalt Institute publication "Superpave Series No. 2 (SP-2, 3rd edition) Mix Design Manual" and
3. the latest edition of Department mix design computer programs, policies, procedures, and forms.

Mix Design for other mix types will be performed as noted in the applicable specifications for that mix type.

The request for the MD/JMF approval will be submitted to the Asphalt Design Engineer on the Department's Form QMS-1 (See HMA/QMS Asphalt Manual) with attached design data, proposed JMF target values, and forms as noted. The information and data that are required on the mix design are described in detail in Article 610-3 of the Standard Specifications or applicable Project Special Provisions and/or in the HMA/QMS Asphalt Manual. In addition, the Contractor is required to submit the design data in electronic form using the Department's mix design program.

Section 610 of the Standard Specifications also covers the requirements, design criteria and policies concerning recycling of asphalt pavement materials (RAP) and recycled asphalt shingle materials (RAS). The Contractor has the option to use a recycled plant mix in lieu of all

virgin plant mix. However, with the exception of the limitations on the percentages of reclaimed materials and associated adjustments in the required binder grade, recycled mixes and virgin mixes all meet the same specifications and design criteria. This means that the same tests, test frequencies, and test requirements will apply both during design and during production. Recycling is discussed in more detail at various locations in the HMA/QMS Asphalt Manual.

## (B) MIX DESIGN CRITERIA

The design requirements and criteria for the various Superpave mix types are given in Table 610-1 and Table 610-2, Section 650 for Open Graded Asphalt Friction Course, Section 652 for Permeable Asphalt Drainage Course, Section 661 for Ultra-thin Bonded Wearing Course, and Section 663 for Hot In-Place Recycled Asphalt Concrete.

## (C) JOB MIX FORMULA

The Contractor is required to have on hand at the asphalt plant the approved mix design and associated job mix formula (JMF) issued by the Department prior to beginning the work. The job mix formula for each mixture will remain in effect until modified in writing by the Engineer, provided the results of QMS tests performed in accordance with Section 609 on material currently being produced conform with specification requirements.

### "MASTER" JOB MIX FORMULA PROCEDURES

Once a mix design for a specified mix type has been approved, and if the Pavement Construction Engineer is in concurrence with the design and proposed target values, the JMF data will be entered into HiCAMS. The Contractor will then be furnished 2 copies of the approved "Master" JMF with attached copies of the mix design data. This "Master" JMF will be for a specific plant and will serve for all projects on which that given JMF for the specified mix type is to be used. The Contractor will then place 1 copy of this MD/JMF assembly **on file at the asphalt plant QC field laboratory** for use by all QMS personnel. This process is discussed in more detail in the HMA/QMS Asphalt Manual.

### PROJECT FILE JOB MIX FORMULA PROCEDURES

Job Mix Formulas (JMF) are maintained in HiCAMS, including revised and voided JMF's. HiCAMS automatically pulls information from the JMF to calculate the quantity of asphalt binder to be paid based upon the quantity of plant mix material placed and JMF in effect at the time the work is performed. Since copies of those JMF can be obtained at any time, the Engineer is not required to maintain paper copies of the JMF within the project Files.

When a given JMF is revised, the void date will be entered on the voided formula by the Pavement Construction Engineer's office and this date will appear on all copies obtained through the computer after that date. The new or revised JMF will show the new number assigned and the effective date. This new JMF will be entered into the computer system and the cycle repeated as noted in the "Master" JMF procedures. **Again, it is critical that the QC Technician has the correct JMF number and shows same on his daily reports**. If the JMF is revised, the technician at the plant will be advised of the new JMF number at that time and will note the revised number and date on the copy posted at the plant. This revised JMF will be used until the Contractor receives and posts the new JMF at the plant.

## 610-4 WEATHER AND TEMPERATURE LIMITATIONS FOR PRODUCING AND PLACING ASPHALT MIXTURES

Weather, temperature, and seasonal limitations must be met before producing or placing asphalt mixtures. These limitations are dependent upon the type of material, layer being placed, layer thickness, air temperature, and road surface temperature. Meeting the requirements of the weather and temperature limitations does not preclude the enforcement of compaction and surface requirements of the Specifications. If the required density, surface tolerances and/or an acceptable surface finish cannot be achieved, the Contractor shall be so advised and paving operations shall cease until these requirements can be met.

Asphalt mixtures shall not be produced or placed during rainy weather. In the event unpredictable rain begins after paving operations have started, the plant production shall immediately cease. If the Contractor requests and **the Engineer grants approval**, he may be allowed to place the mixture which was in transit if an acceptable product can be obtained with proper density and surface smoothness. The Technician shall specifically advise the Contractor that he is placing the mixture at his own risk, and that the material is subject to removal if problems are encountered at a later date. However, in no event should a mixture be placed in standing water or when the moisture on the surface to be paved would prevent proper bonding.

There are seasonal limitations on placing the final layer of pavement. This requirement is included to assure the relatively thin final surface layer, which is subject to cooling quickly, can be adequately compacted with proper surface texture and smoothness. There is also a requirement that base and intermediate courses be covered with either at least one surface layer or a sand seal prior to winter exposure. This is intended to minimize water penetration and damage from rain, sleet, snow, freezing and thawing, etc. To comply with these requirements and to assure the quality and integrity of the pavement, takes careful planning and coordination on the part of both the Contractor and the Department.

## 610-5 ASPHALT MIXTURE PRODUCTION

### (A) GENERAL

Whether batch plants, continuous mix plants, or drum mixers are utilized, the plant is required to be certified by the Department before asphalt mixture production begins. Since continuous mix plants are rarely used, they will not be covered in this Manual. The QA Supervisor should consult with the Pavement Construction Section if a continuous mix plant is used.

Most asphalt plant mixes are produced in either batch plants or dryer drum plants. Any completely automatically controlled plant that does not meet all the requirements of these specifications for conventional batch, continuous or dryer-drum mixing plants may be utilized on a project-by-project basis if uniformly consistent mix meeting all requirements can be produced, and the plant has been approved in writing by the State Construction Engineer.

All plants must be certified as meeting the requirements of the Specifications prior to beginning production on DOT projects. The initial inspection for certification will be made by the Pavement Construction Engineer or his representative upon request from the Contractor. Any plant that is significantly modified, relocated, or that changes ownership must be recertified prior to use. The Pavement Construction Section or its designated representative will conduct the inspection for renewal certification. A certificate of compliance will be issued to the plant owner and shall be displayed at the plant site, preferably in the plant control room (See example

in the HMA/QMS Asphalt Manual). A complete listing of certified plants will be maintained and available on HiCAMS. The listing is also available through the Materials & Tests Unit's "Comprehensive Approved Listing Program."

Certification of a plant does not signify approval of the Contractor's field laboratory or the approval and accuracy of weighing devices. Refer to the appropriate sections of the Specifications and the HMA/QMS Asphalt Manual for specific requirements for these items. Continued compliance of the asphalt plant with the Specifications is the responsibility of the Contractor.

Aggregate stockpiles are to be inspected for objectionable materials such as clay or other deleterious material. Any aggregate found to contain objectionable material should be rejected until the objectionable materials can be removed.

It is the responsibility of the Contractor to store and handle aggregates in a manner, which minimizes degradation and segregation and avoids contamination. Provisions must be made to prevent intermingling of the different aggregate stockpiles. Such provisions should include sufficient space to allow clear separation of the aggregate piles, silos, or use of bulkheads between stockpiles. These bulkheads should be of sufficient size to prevent spillage between different aggregate sizes.

Heat stable anti-strip additives are added to the asphalt cement (AC) in many asphalt mixes in an effort to prevent the separation of the AC from the aggregate particles (stripping). Anti-strip additives must be approved by the Department prior to use. When anti-strip additives are required in hot mix asphalt, the additive shall be introduced and mixed into the asphalt cement at either the supplier's terminal or at the asphalt plant site. In-line blending equipment shall be used at either location. The HMA/QMS Asphalt Manual includes more details on equipment requirements and calibrations.

## SCALES AND PUBLIC WEIGHMASTER (ARTICLE 106-7)

Specifications for weighing asphalt materials that are to be paid for on a per-ton basis can be found in Article 106-7 of the Standard Specifications. The requirements for automatic weighing, recording, and printing of tickets are listed under this same article along with provisions for checking the scales by re-weighing a truck load of material on another set of approved platform scales. When re-weighing a truckload of mix, the weights should check within plus or minus 0.4 percent and documented on the QMS-7 form.

The requirements of this article and approval of the weighing equipment is covered by the initial plant certification required by Article 610-5 of the Standard Specifications. It is the QA Supervisor's responsibility to assure that the Contractor continues to meet the requirements of Article 106-7 before weight certificates are issued.

Truck or Platform Scales must meet the requirements of Standard Specifications Article 106-7, "Scales and Public Weighmaster." The Department of Agriculture must certify the platform scales before they are used to determine the weight of mixture for payment purposes. Additional information and guidelines are noted in Section 5 of the HMA/QMS Asphalt Manual.

## EQUIPMENT REQUIREMENTS FOR ASPHALT PLANTS

Sub-articles 610-5(B) through 610-5(E) cover the specific equipment requirements for each type of asphalt plant. These requirements are discussed in detail in Sections 5 and 6 of the HMA/QMS Asphalt Manual .

## 610-6 HOT MIX STORAGE SYSTEMS

To prevent plant shutdowns due to temporary interruptions of paving operations or shortages of trucks to haul material from the plant to the paving site, all dryer drum mixers and many batch asphalt plants are equipped with storage silos and/or surge bins for temporary storage of asphalt hot mix. Newly made hot mix is deposited by conveyor or hot elevator into the top of the bin or silo and is discharged into trucks from the bottom.

Non-insulated surge storage bins are usually quite small and can store hot mix only for short periods of time. Insulated silos can store hot mix up to 24 hours with no significant loss of heat or quality. Heavier insulation and a method of heating are provided to maintain the temperature of the mix. The capacity of these bins is normally greater than that for surge bins and the material may be stored for longer periods without damage. Capacities range as high as several hundred metric tons (tons).

Storage silos and surge bins work well if certain precautions are followed, but they can cause and/or contribute to segregation of the mix if not operated properly. Hot mix is dumped into the top and falls vertically into the structure. It is good practice to use a baffle plate, batching gob hopper, or similar device at the discharge end of the conveyor used to load the silo. The baffle helps to prevent the mix from coning and segregating as it drops into the silo or bin. It is also recommended to keep the hopper at least 1/3 full when possible to minimize segregation as the hopper empties and to help to keep the mix hot.

Mix that is discharged from the silo or bin must meet the requirements of the job mix formula. The system must be designed so that segregation of the mix is held to a minimum. Frequent visual checks of the mix must be made by the Plant Technician to make certain segregation has not occurred during the charging of the silo or bin and/or during loading into trucks. Visual checks for segregation should be made frequently, especially on base and intermediate mixes, since they are more subject to segregation.

Samples of the mix for testing purposes will be taken directly from the truck body in accordance with procedures outlined in the HMA/QMS Asphalt Manual.

## 610-7 HAULING OF ASPHALT MIXTURE

The truck bodies in which the mix is to be hauled should be inspected to make sure that the bed has been lightly coated with an approved release agent to prevent the mixture from adhering to the bed. **Diesel fuels or other petroleum products are not approved releasing agents.** After the bed is coated, any excess solution must be adequately drained before any mix is allowed to be loaded. Excess solution can be extremely detrimental to mixture that it contacts.

The finished mix should be observed frequently and the temperature should be checked at random intervals and recorded. The Contractor must provide a platform near the truck loading area from which the mix may be observed, temperature of the mix determined and from which samples of the mix can be secured. The Technicians should assure that all trucks are properly covered and covers securely fastened before leaving the plant to protect the mix from chilling due to cool weather or potential rain showers. Covers must be of sufficient length and width to cover the entire load and must be repaired or replaced when damaged or torn.

## 610-8 SPREADING AND FINISHING

Spreading, finishing, and compaction are extremely important operations if a high quality, visually pleasing, long lasting pavement is to be constructed. Placing and compacting the asphalt mixture is the operation to which all the other processes are directed.

Asphalt mix is delivered to the paving site in trucks and may be deposited directly into the paver, or in windrows in front of the paver, or transferred to the paver by specially designed materials transfer equipment. The paver then spreads the mix to the required grades, cross-section thickness, and widths shown on the plans and typical sections as it moves forward. In doing so, the paver partially compacts the material and provides a smooth, uniform texture. Immediately thereafter and while the mix is still hot, steel-wheeled, vibratory or rubber-tired rollers or some combination of these are driven over the freshly paved mat, further compacting the mix to the required density and texture. Rolling is usually continued until the pavement is compacted to the required density, or the temperature has dropped to a point where further compaction may produce detrimental results.

Paving operations require careful planning, preparation, co-ordination, and communication between all parties. The surface to be paved must be properly prepared. Enough vehicles and equipment must be available and in good operation to provide a steady flow of materials and progress without delays. Plant production must be closely coordinated with the paving operation, and the compaction of freshly placed mixture must be prompt and adequate.

Nowhere in the construction of hot-mix asphalt pavements are the efforts and skills of workers, operators, and technicians more apparent than in the placing and compacting of the hot-mix in the roadway. Having the necessary knowledge and skills of the paving operation and having pride in the final product can mean the difference between a durable, smooth-riding pavement and a rough, unsound, unsightly pavement that will not perform as was intended, but also, is a nuisance to drive on.

Recent national surveys of the traveling public (taxpayers) indicate that their perceptions of high quality pavements are those that are smooth and last for a long time. While the public is usually neither aware nor concerned about other properties such as gradation, binder content, voids properties, density, etc., we as Engineers and Contractors know that mix quality, pavement quality, smoothness, and density are significantly related. Smoothness is an indicator of a pavement that has uniform and consistent mix properties without segregation during placement. Achieving uniform density at the proper level during placement and compaction means a pavement which will have more rut resistance, less permeability, less oxidation, less fatigue cracking, be more durable, require less maintenance and therefore, last longer. The key is communication and consistency. To meet these objectives requires substantial planning on the part of all parties involved.

Because planning and communication are so essential for successful paving operations, a pre-paving construction conference should be held before work begins. Such a conference allows the Department's Project Engineer, the Contractor's Paving Superintendent, Traffic Control personnel, Trucking personnel, Roadway and Density Technicians, and others directly involved with the operation the opportunity to discuss common questions and items of concern, answer questions and to plan the paving operation accordingly. Some common items of interest are listed in Section 9.4 of the HMA/QMS Asphalt Manual.

Sections 9 and 10 of the HMA/QMS Asphalt Manual discuss in detail the requirements of the Specifications, good construction practices, typical calculations, and responsibilities and

duties of QC and QA Roadway Technicians. Examples of rate of spread and tons of mix required are illustrated in the HMA/QMS Asphalt Manual .

There are places on many jobs where spreading with a paver is either impractical or impossible. In these cases, hand spreading may be permitted. Placing and spreading by hand should be done very carefully and the material distributed uniformly so that the segregation of the coarse aggregate and the asphalt mortar will be avoided. When the asphalt mix is dumped in piles, it should be placed far enough ahead of the shovelers and rakers to necessitate moving the entire pile. Also, sufficient space should be provided for the workman to stand on the base and not on the freshly mixed material. If the asphalt mix is broadcast with shovels, almost complete segregation of the coarse and fine portions of the mix will result. The material should be deposited from the shovels into small piles that are spread with lutes or rakes. In the spreading process, all material should be thoroughly loosened and evenly distributed. Any part of the mix that has formed into lumps and does not break down easily should be discarded. After the material has been placed and before rolling is started, the surface should be checked with templates and straightedges and all irregularities corrected.

## 610-9 COMPACTION

Compaction is accomplished by arranging the aggregate particles closer together in a position in which the asphalt binder can hold them in place. Compaction accomplishes 2 important goals:

1. It develops the strength and rut resistance of the mix
2. It closes passages through which water and air would otherwise penetrate thus causing faster aging, freeze-thaw damage, and stripping.

The need for a pavement to be compacted to the required density is better understood when the effect of air, water, and traffic on an under-compacted pavement is realized. The voids in an under-compacted mix tend to be interconnected and therefore, permit the intrusion of air and water throughout the pavement. Air and water carry oxygen, which in turn, accelerates the oxidation of the asphalt binder in the mix, causing it to become brittle. Consequently, the pavement itself will ultimately fail as it can no longer withstand the repeated deflections due to traffic loading. The internal presence of water at freezing temperatures can also cause an early failure in the pavement due to expansion of the freezing water.

A pavement that has not been adequately compacted during construction has not developed its potential design strength and therefore, may push, shove, and rut from traffic utilizing the pavement. However, unless the mix is properly designed and adequate voids remain in the compacted mix, the pavement will likely flush and tend to become unstable due to further reduction of void content under traffic and/or thermal expansion of the asphalt. The desired as-constructed void content is approximately 8 percent or less for dense-graded mixes. At this level, the voids are usually not interconnected. When the air void content is too high, the pavement will tend to ravel and disintegrate. When the air-void content is too low, there is a danger of the pavement flushing leading to poor skid resistance and becoming unstable.

Compaction is the final stage of hot-mix asphalt paving operations. It is the stage at which the full strength of the mixture is developed and the smoothness and texture of the mat is established. Therefore, the Technicians must be particularly observant of the compaction process.

There may be occasions during resurfacing operations where the mixture is totally within the job mix formula and the Contractor is applying every effort to achieve density and is unable to do so due to the poor condition of the existing pavement or underlying base or subgrade. If it

is determined that this is the cause, the Engineer should advise the Division Engineer and the State Construction Engineer, and a determination will be made if the lower density results will be accepted, and/or other appropriate action(s) be taken. In some cases, revisions in the job mix formula such as adding additional asphalt cement may be made in order to obtain a pavement that will not have a high void content and, therefore, be subject to intrusion of air and water. However, we must assure ourselves that failure to obtain density is in fact due to yielding base or the condition of the existing pavement and not due to lack of proper equipment or lack of compactive effort being applied.

Rolling and compaction of asphalt pavements becomes more difficult due to cooler ambient temperature and cooler temperature of the base on which the mix is being placed. This is particularly true when placing the thinner surface course mixtures.

**The temperature of a mixture during the compaction process is probably the single most important factor in achieving the required density on an asphalt pavement**. This temperature must be high enough as well as uniform throughout the thickness of the mat if compaction is to be achieved. The mix temperature affects the viscosity of the asphalt binder, which in turn determines the ability of the mixture to be compacted. The hotter the mix during compaction the more fluid the asphalt binder and the less resistant the mix is to compaction. At the same time, we must be careful not to overheat the mixture to temperatures, which may result in damage to the asphalt binder. Also, if the mix is excessively hot, the rollers may need to wait for the mix to cool in order to prevent "picking up" on the roller wheels and to support the weight of the roller. This delay results in differential cooling between the surface and interior of the mat and may result in "heat checking" when rolled. Heat checking is the formation of small hairline cracks in the mat perpendicular to the direction of roller travel. Many times this "heat checking" is misconstrued as overrolling when, in fact, it is caused by not rolling the mat while the temperature is uniform from top to bottom. The relatively cool non-plastic surface deflects because the interior of the mat is still hot and in a plastic state, cracks appear, and density becomes very difficult if not impossible to achieve.

Naturally, cooler air temperatures, high humidity, stronger winds, and cooler base temperatures on which the mix is being placed drastically increases this rate of cooling and shortens the time in which compaction must take place. It becomes even more critical that the rolling operation follows closely behind the paver, so that there is no delay between placing and compacting the mat. We have all heard the expression "bump the spreader" with the roller. When thin lift pavements are being placed from late fall to spring or during any cool weather, this expression literally describes what must be done if specification density and tight smooth surface textures are to be obtained.

Many times, roller operators and inspection personnel tend to let the rolling operation lag behind the paver as they did back during the hot summer months when the rate of cooling of the mix was not as critical. As the weather cools, we sometimes fail to get out of our "bad habits" and to adjust rolling procedures to compensate for the faster rate of cooling with the result being inadequate density and poor surface texture**. It should be noted, however, that increasing the roller speed is not the solution** to this problem. Steel wheel roller speeds in excess of 3 miles per hour (5 km per hour) only tends to reduce the amount of compactive effort to a given area of pavement and very possibly will result in a rough surface. Some possible solutions to this problem are (1) slow the paver down in order that rolling operation can keep up, (2) add another roller, or (3) increase roller weight by adding ballast.

In addition to keeping accurate detailed records and observing that the operation is performed safely, the Technician must also be sure that compaction is done properly and that the finished pavement meets all specifications. To achieve this, the Technician must understand the

compaction procedure and the equipment involved. The Technician must acquire samples of the compacted mat or take readings with special instruments to determine mix density and smoothness.

Section 9 of the HMA/QMS Asphalt Manual covers in detail compaction specifications, roller types, rolling and compaction procedures, factors affecting compaction, rolling phases, and procedures for rolling and compacting transverse and longitudinal joints.

## 610-10 DENSITY REQUIREMENTS

This Article of the Specifications specifies the minimum density requirements for the various Superpave mix types and which categories of pavements must be tested for density. Also defined are areas that do not require density testing provided appropriate compaction equipment and procedures are used.

For QMS projects, the Contractor selects the density acceptance method to be used on a project. Testing to verify field compaction can be done by either obtaining cores from the pavement or testing with a nuclear density gauge. However, nuclear density readings still must be correlated with core sample densities. The Engineer is normally advised at the pre-construction conference which method will be used.

When the Contractor elects to utilize nuclear methods as the means of density control, the requirements and procedures shall be as specified in Articles 609-5(D), 609-6, and 609-7. Reference should also be made to the QMS Nuclear Gauge Operator's Manual published by the Materials & Tests Unit and the HMA/QMS Asphalt Manual . These manuals describe in detail the procedures for nuclear density control for both QC and QA testing.

When the Contractor elects to utilize core sample methods as the means of density control, the requirements and procedures shall be as specified in Articles 609-5(D), 609-6, and 609-7. Reference should also be made to the appropriate sections in the HMA/QMS Asphalt Manual pertaining to core sample methods of density control.

Regardless of the method used, density tests must be made on a random location basis. The Nuclear Gauge Operator’s Manual outlines the use of a random numbers table to locate test sites when using nuclear gauge control. A similar random concept must be utilized when determining the core sample location within a lot as specified in Section 10 of the HMA/QMS Asphalt Manual.

## 6l0-l1 JOINTS

### (A) TRANSVERSE JOINTS

A transverse joint is constructed at any point where the paving operation is interrupted for a period of time (an average time of 15 minutes or more) and the paving operation is to be resumed later. The type of transverse joint to be constructed depends primarily on whether traffic will be traveling over the mat before paving is resumed.

The proper construction of transverse joints is absolutely essential if a smooth riding surface is to be obtained and a durable, ravel-free joint is to be achieved. A poorly constructed transverse joint is noticeable as a pronounced bump in the pavement, many times with a very open surface texture and low density. The formation of transverse joints must be done while the mix is still hot enough to be easily workable and the joint must be thoroughly rolled and compacted before the mix becomes chilled. Consequently, the Technicians, both QC and QA, must be on hand whenever a transverse joint is made in order to ensure it is done properly. Discovering hours after construction that a transverse joint is unsatisfactory does no good, because joint construction can only be corrected while the mix is still hot and workable. Once the mix cools, corrections can be made only by cutting out and replacing the joint. Unfortunately, removing and replacing asphalt due to poor transverse joint construction creates two transverse joints where only one previously existed. Paving should not progress until the joint has been completed.

**Transverse joints are constructed in three basic steps**: (1) ending the lane or width of pavement (with proper compaction and thickness) at the point of work stoppage,
(2) resumption of paving operations at a subsequent time, and (3) rolling the transverse joint. These steps are described in detail in Section 9 of the HMA/QMS Asphalt Manual.

### (B) LONGITUDINAL JOINTS

The proper location and construction of longitudinal joints is absolutely essential if a smooth riding surface is to be obtained and a durable ravel-free joint is to be achieved. Care must be exercised in the formation of longitudinal joints between adjacent lanes of pavement and at the edges of concrete gutter or concrete pavement. It is most important that these joints be tightly sealed to prevent the intrusion of water into and through the joint. Maximum compaction must be obtained at joints to prevent further compaction when exposed to traffic thereby resulting in low uneven joints and also to prevent the raveling of the pavement after exposure to harsh weather conditions and traffic.

When placing the final surface course adjacent to concrete gutter or concrete pavement, adequate mixture should be placed such that the surface of the fully compacted mat will be 1/8 to 1/4 of an inch higher than the adjacent concrete after rolling. Rolling of the joint between hot mix and concrete should be done as soon as possible. With possibly a few exceptions, a joint matching shoe should not be used.

There are several key factors in achieving tight, smooth, and durable longitudinal joints. These include: (1) **providing adequate mix when placing the adjoining lane to allow adequate compaction without bridging** (2) **keeping the joint straight,** (3) proper tacking of the previously placed mat exposed edge, (4) offsetting the location of joints in multi-lane multi-layer pavements, (5) locating the joints outside of the wheel path, (6) **properly overlapping the previously placed mat at the joint,** and (7) location of the rollers when compacting the unconfined edge of the first lane and the confined edge of the adjoining lane. These factors are described in detail in Section 9 of the HMA/QMS Asphalt Manual.

**It should be noted that currently recommended procedures for constructing and compacting longitudinal joints is somewhat different than procedures used several years ago. The current recommended procedures are covered in detail in Section 9-10 of the HMA/QMS Asphalt Manual.**

## 610-12 SURFACE REQUIREMENTS AND ACCEPTANCE

This Article of the Specifications requires the Contractor to construct quality pavements using quality paving practices and procedures as required by the specifications and as recognized by the asphalt paving industry. The finished pavement surface must be uniform, smooth, and true to plan grade and cross slope. Many of these practices and procedures are addressed in Sections 9 and 10 of the HMA/QMS Asphalt Manual.

Pavement imperfections resulting from unsatisfactory workmanship, including but not limited to segregation, improper longitudinal joint construction, placement or alignment, non-uniform edge alignment, non-uniform texture or excessive pavement repairs will be considered unsatisfactory and if allowed to remain in place will be accepted in accordance with Article 105-3.

Continuity and uniformity of operations are two key elements essential to securing a good quality pavement surface; therefore, the speed of the paver should be regulated by the plant's production capacity and delivery of material to the paver, within limits. By observing the surface texture behind the machine and behind the roller and checking the surface with a straightedge, a malfunction in the paver, rolling operation, or non-uniformity of mixture may be detected. Both QC and QA Roadway Technicians must insist on prompt action to locate any deficiencies or defects that occur. Some of the most common problems encountered with possible causes are listed in the **Mat Problem Trouble Shooting Guide** and in the **Segregation Diagnostic Guide** in the Appendix of the HMA/QMS Asphalt Manual. Mat deficiencies, segregation, slope and thickness, surface texture, and smoothness are also discussed in detail in the HMA/QMS Asphalt Manual.

Article 610-12 of the specifications requires that in the event the laydown of the mix is unsatisfactory due to ride quality, excessive tearing, corrugation, rough surface, segregation, or other mat deficiencies, the roadway Technician will advise the Contractor that the work is unsatisfactory and that the work will continue under limited procedures. The definition of limited and the subsequent operating procedures are described in detail in the HMA/QMS Asphalt Manual. Mix placed under the limited production procedures for unsatisfactory laydown or workmanship will be evaluated for acceptance in accordance with Article l05-3.

This Article also includes the pavement smoothness requirements. Pavement smoothness is an extremely important factor in pavement construction for several reasons. The traveling public (taxpayers) demand smooth pavements and it is a proven fact that smooth pavements last longer, require less maintenance, and are cheaper to drive on. Smoothness is usually a good indicator of a uniform pavement and therefore a good quality pavement.

All pavements on which there will be traffic include smoothness requirements. There are 3 basic methods of measuring smoothness: (1) a 10 foot stationary straightedge, (2) the Hearne Profilograph and the Inertial Profiler as required in the Project Special Provision FINAL SURFACING TESTING – ASPHALT PAVEMENTS and Article 610-13 – Final Surface Testing and Acceptance. The requirements and procedures for all methods are described in detail in the Specifications and HMA/QMS Asphalt Manual.

## 610-13 FINAL SURFACE TESTING AND ACCEPTANCE

### International Roughness Index

The International Roughness Index (IRI) is the roughness index most commonly obtained from measured longitudinal road profiles. It is calculated using a quarter-car vehicle math model, whose response is accumulated to yield a roughness index with units of slope (in/mi, m/km, etc.). IRI has become the road roughness index most commonly used worldwide for evaluating and managing road systems.

Inertial profilers measure the pavement surface profile using a distance measurement transducer, noncontact vertical displacement transducer (line laser technology), an accelerometer, and a computer. The distance measurement transducer operates similarly to a car's odometer, but more precisely. The noncontact vertical transducer measures the distance the device and the pavement surface at selected intervals. The accelerometer determines the inclination of the profiler as it ascends and descends hills and corrects for any movement of the vertical displacement transducer relative to the ground caused by the suspension. The computer collects and records all the data from the devices and uses it to calculate the IRI index to describe the ride quality of the pavement.

The Department gives the option of using either the Hearne straightedge or an inertial profiler to quantify ride quality of newly placed HMA pavements which required final surface testing and acceptance.

The measurement of IRI is covered in several standards from AASHTO and ASTM: AASHTO M 328, ASTM E1926, AASHTO R 56, AASHTO R 57, and others.

The equipment should be configured to record actual elevation of the pavement surface. The profiler's internal IRI calculation mode should not be used. The software is required to produce electronic inertial road profiles in a format compatible with the latest version of FHWA's ProVAL (Profile Viewing and Analysis software). The profile data shall be filtered with a cutoff wavelength of 300 feet. The interval at which relative profile elevations are reported shall be one inch.

## 610-14 DENSITY ACCEPTANCE

The Department will evaluate the asphalt pavement for density acceptance on a lot by lot basis after the asphalt mix has been placed and compacted. This acceptance process will be conducted using the Contractor's quality control test results, the Department's quality assurance test results, including verification samples, and by observation of the Contractor's density quality control process conducted in accordance with Section 609. This Article defines how lots will be established, what constitutes a failing lot and how applicable pay factors are determined.

When the pavement is considered “other” construction, the pay factor for density deficiency is typically reduced in half of the new construction formula

## 610-15 MAINTENANCE

The Contractor is required to maintain the pavement in an acceptable condition and to repair any defects or damage that may occur until final acceptance of the project.

## 610-16 MEASUREMENT AND PAYMENT

This article outlines the various contract descriptions under which the work will be paid, including the various mix types. Asphalt binder will be paid for as provided in Article 620-4.

There is no direct payment for the use of a materials transfer vehicle when required by the specifications as it is considered incidental to the cost of the mix.

**TECHNICIAN'S CHECKLIST**
**SECTION 610**
**ASPHALT-PAVEMENT PLANT MIX - GENERAL**

1) Study Specifications, Plans, and Special Provisions.

**THE CONTRACTOR SHALL:**

2) Select a location for calibration testing 0.10 miles in length. The location should be reasonably flat and measured and approved by the Engineer.
3) Perform daily calibration procedures and record measurements and calibration settings in a calibration log book. Calibrations should include Distance measurement (within ±1.00 ft.), vertical displacement (within ±0.01181 inches), and accelerometer (within manufacturer's instructions which may include both a static dynamic test.).Calibration Log should include date of calibration, Instrument calibrated, measurement results, and any adjustments, in any, made to the equipment based on the results. Calibration testing should be done in the presents of the Engineer or his representative. A copy of the calibration log should be given to the Engineer each day.
4) Provide IRI data in accordance with the most current version of ASTM E 1926.
5) Provide a competent operator trained in the operation of the inertial profiler per AASHTO R 57.
6) Provide the user selected inertial profiler settings to the Engineer or his representative for the project records.
7) Provide equipment in good working condition.
8) Remove all objects or foreign materials on the pavement prior to longitudinal pavement profile testing.
9) Operate the profiler at the manufacturer's recommendations (The manufacturer's recommendation should be provided to the Engineer or his representative).
10) Operate the Profiler at a speed which is constant within ±3mph of the intended speed.
11) Operate the in the direction of the final traffic pattern.
12) Collect IRI data from both wheel paths during the same run (it is permissible to collect data one wheel path at the time if each wheel path is tested and evaluated separately).
13) When using an inertial profiler that collects a single trace per pass should take care to ensure that the measurements from each trace in a travel lane start and stop at the same longitudinal locations.
14) Operate the automatic triggering method at all times unless impractical.
15) Reach the intended operating speed before entering the test section (the runup and runout distances should be sufficient to obtain the intended operating speed and to slow down after testing is complete).
16) Mark the limits of structures and other special area to be excluded from testing using the profiler's event identifier.
17) Perform all smoothness testing in the presents of the Engineer or his representative.
18) Perform surface testing on the finished surface of the competed project, or at the completion of a major state of construction as approved by the Engineer.
19) Coordinate with and receive authorization from the Engineer before starting smoothness testing.
20) Perform all smoothness testing with 7 days after receiving authorization from the Engineer.
21) After testing, transfer immediately the profile data, compatible with the latest version of ProVAL, from the profiler portable computer's hard drive to a write once storage media

(DVD-R or CD-R) or electronic media approved by Engineer. The media approved will not be returned.

22) Label the electronic media with the project number, route, file number, date, operator, and termini of the profile data.
23) Submit report data and documentation of the evaluation for each section to the Engineer within 10 days after completion of the smoothness testing. See the example below. (The evaluation should be done in tabular form with each 0.10 mile segment occupying a row. Include each row with the beginning and ending station for the section, the length of the section, the original IRI values from each wheel path, and the MRI value for the section. Each continuous run for a section will occupy a separate table and each table will include a header with Project No., County, Roadway designation, lane designation, JMF used on final layer, dates of the smoothness testing, and the beginning and ending stations of the continuous run. Summarize each table at the bottom. )

**THE ENGINEER OR HIS REPRESENTATIVE SHALL:**

1) Study Specifications, Plans, and Special Provisions.
2) Witness all daily calibration testing.
3) Coordinate daily testing schedules.
4) Note daily calibration testing has been done in the Daily Inspector's Diary.
5) Observe area before smoothness testing begins to see that all objects or foreign materials on the pavement prior to longitudinal pavement profile testing have been removed.
6) Observe all smoothness testing.
7) Observe the operator to see that he/she are keeping a steady line in the lane.
8) Retrieve data from the operator at the conclusion of smoothness testing on the approved media.
9) The Engineer should acquire a copy of the latest version of ProVAL software so as to check Contractor's figures.
10) Record in diary all conversations, observations, spot checks made, and work performed.

Sample Report:

| | |
|---|---|
| Contract # | C 000755 |
| FILENAME: | F:\20220\20220N2.P01 |
| DATE COLLECTED: | 5/3/2011 |
| SENSOR CAL DATE: | 1/4/2011 |
| COUNTY: | Randolph |
| ROUTE: | 20000220 |
| DIRECTION: | North(+) |
| LANE: | 2 |
| JMF # | 00-0001-832 |
| COMMENT1: | Somewhat rough |
| OPERATOR: | Eric House |
| DRIVER: | Eric House |
| VEHICLE: | 17 |
| DCF: | 7052.5 |
| TIME COLLECTED: | 9:59:58 |

| Miles | | | IN/MI | | |
|---|---|---|---|---|---|
| From | To | Rough Dist | IRI 1 | IRI 2 | MRI (Avg IRI) |
| 0.0 | 0.1 | 0.1 | 95 | 90 | 92 |
| 0.1 | 0.2 | 0.1 | 87 | 83 | 85 |
| 0.2 | 0.3 | 0.1 | 102 | 77 | 90 |
| 0.3 | 0.4 | 0.1 | 100 | 79 | 89 |
| 0.4 | 0.5 | 0.1 | 98 | 97 | 97 |
| 0.5 | 0.6 | 0.1 | 207 | 190 | 199 |
| 0.6 | 0.7 | 0.1 | 57 | 52 | 55 |
| 0.7 | 0.8 | 0.1 | 78 | 55 | 67 |
| 0.8 | 0.9 | 0.1 | 56 | 52 | 54 |
| 0.9 | 1.0 | 0.1 | 66 | 48 | 57 |
| 1.0 | 1.1 | 0.1 | 53 | 43 | 48 |
| 1.1 | 1.2 | 0.1 | 62 | 59 | 60 |
| 1.2 | 1.3 | 0.1 | 61 | 54 | 57 |
| 1.3 | 1.4 | 0.1 | 70 | 57 | 64 |
| 1.4 | 1.5 | 0.1 | 71 | 61 | 66 |
| 1.5 | 1.6 | 0.1 | 65 | 61 | 63 |
| 1.6 | 1.7 | 0.1 | 65 | 52 | 58 |
| 1.7 | 1.8 | 0.1 | 98 | 93 | 96 |
| 1.8 | 1.9 | 0.1 | 67 | 62 | 64 |
| 1.9 | 2.0 | 0.1 | 57 | 63 | 60 |
| 2.0 | 2.1 | 0.1 | 73 | 71 | 72 |
| 2.1 | 2.2 | 0.1 | 70 | 67 | 68 |
| 2.2 | 2.3 | 0.1 | 64 | 67 | 66 |
| 2.3 | 2.4 | 0.1 | 65 | 66 | 66 |
| 2.4 | 2.5 | 0.1 | 65 | 79 | 72 |
| 2.5 | 2.6 | 0.1 | 75 | 69 | 72 |
| 2.6 | 2.7 | 0.1 | 62 | 66 | 64 |
| 2.7 | 2.8 | 0.1 | 68 | 64 | 66 |
| 2.8 | 2.9 | 0.1 | 69 | 67 | 68 |
| 2.9 | 3.0 | 0.1 | 74 | 83 | 79 |
| 3.0 | 3.1 | 0.1 | 63 | 56 | 59 |
| 3.1 | 3.2 | 0.1 | 65 | 59 | 62 |
| 3.2 | 3.3 | 0.1 | 67 | 56 | 62 |
| 3.3 | 3.4 | 0.1 | 70 | 48 | 59 |
| 3.4 | 3.5 | 0.1 | 60 | 52 | 56 |
| 3.5 | 3.6 | 0.1 | 71 | 55 | 63 |
| 3.6 | 3.7 | 0.1 | 55 | 56 | 56 |
| 3.7 | 3.8 | 0.1 | 67 | 56 | 62 |
| 3.8 | 3.9 | 0.1 | 90 | 65 | 78 |
| 3.9 | 4.0 | 0.1 | 72 | 64 | 68 |
| 4.0 | 4.1 | 0.1 | 80 | 68 | 74 |

| | | | | | |
|---|---|---|---|---|---|
| 4.1 | 4.2 | 0.1 | 83 | 65 | 74 |
| 4.2 | 4.3 | 0.1 | 119 | 149 | 134 |
| 4.3 | 4.4 | 0.1 | 75 | 110 | 92 |
| 4.4 | 4.5 | 0.1 | 63 | 94 | 78 |
| 4.5 | 4.6 | 0.1 | 79 | 98 | 89 |
| 4.6 | 4.7 | 0.1 | 71 | 84 | 78 |
| 4.7 | 4.8 | 0.1 | 135 | 130 | 133 |
| 4.8 | 4.9 | 0.1 | 85 | 87 | 86 |
| 4.9 | 5.0 | 0.1 | 108 | 123 | 115 |
| 5.0 | 5.1 | 0.1 | 91 | 115 | 103 |
| 5.1 | 5.2 | 0.1 | 72 | 73 | 72 |
| 5.2 | 5.3 | 0.1 | 92 | 74 | 83 |
| 5.3 | 5.4 | 0.1 | 78 | 64 | 71 |
| 5.4 | 5.5 | 0.1 | 91 | 82 | 87 |
| 5.5 | 5.6 | 0.1 | 101 | 92 | 97 |
| 5.6 | 5.7 | 0.1 | 71 | 76 | 73 |
| 5.7 | 5.8 | 0.1 | 62 | 75 | 69 |
| 5.8 | 5.9 | 0.1 | 63 | 74 | 68 |
| 5.9 | 6.0 | 0.1 | 98 | 116 | 107 |
| 6.0 | 6.1 | 0.1 | 59 | 49 | 54 |
| 6.1 | 6.2 | 0.1 | 54 | 41 | 47 |
| 6.2 | 6.3 | 0.1 | 64 | 48 | 56 |
| 6.3 | 6.4 | 0.1 | 136 | 141 | 138 |
| 6.4 | 6.5 | 0.1 | 77 | 81 | 79 |
| 6.5 | 6.6 | 0.1 | 65 | 47 | 56 |
| 6.6 | 6.7 | 0.1 | 84 | 75 | 80 |
| 6.7 | 6.8 | 0.1 | 121 | 108 | 114 |
| 6.8 | 6.9 | 0.1 | 90 | 73 | 82 |
| 6.9 | 7.0 | 0.1 | 83 | 79 | 81 |
| 7.0 | 7.1 | 0.1 | 70 | 68 | 69 |
| 7.1 | 7.2 | 0.1 | 76 | 73 | 75 |
| 7.2 | 7.3 | 0.1 | 92 | 82 | 87 |
| 7.3 | 7.4 | 0.1 | 103 | 73 | 88 |
| 7.4 | 7.5 | 0.1 | 71 | 47 | 59 |
| 7.5 | 7.6 | 0.1 | 69 | 51 | 60 |
| 7.6 | 7.7 | 0.1 | 132 | 73 | 102 |
| 7.7 | 7.8 | 0.1 | 87 | 69 | 78 |
| 7.8 | 7.9 | 0.1 | 60 | 54 | 57 |
| 7.9 | 8.0 | 0.1 | 76 | 44 | 60 |
| 8.0 | 8.1 | 0.1 | 57 | 44 | 51 |
| 8.1 | 8.2 | 0.1 | 63 | 43 | 53 |
| 8.2 | 8.3 | 0.1 | 67 | 53 | 60 |
| 8.3 | 8.4 | 0.05 | 56 | 58 | 57 |
| ========== | ======= | ===== | ======= | ====== | ====== |
| 0.0 | 8.4 | 8.35 | 79 | 73 | 76 |

## SECTION 620
## ASPHALT BINDER FOR PLANT MIX

### 620-1 DESCRIPTION

This Section covers the item of asphalt binder which includes the furnishing of the binder, with anti-strip additive when required, at an asphalt plant and incorporating the binder and anti-strip additive into the asphalt mix.

### 620-2 MATERIALS

Section 1020-2 of the specifications covers the requirements for the asphalt binders. There are 3 basic grades of binders used in most of the Superpave mixes. These grades are PG 64-22, PG 70-22, and PG 76-22. The PG 64-22 is an unmodified binder and is the standard grade used in most mixes. The PG 70-22 may be a modified or possibly unmodified binder and is a slightly less viscous or stiffer binder. The PG 76-22 is a modified binder and is much less viscous and much stiffer than the standard PG 64-22 grade. The general rule of thumb is the heavier the traffic load, the stiffer the binder grade used. However, the binder grade required in a mix is controlled by the mix type itself. Each mix type has a specified binder grade to be used and should not be switched unless approved by the Pavement Construction Engineer. There are some other binder grades specified at times when "special mixes" are used; i.e., PG 70-28 is specified to be used in the Ultra-Thin Bonded Wearing Course mixes.

The requirements for the delivery and acceptance of asphalt materials, including the transport tanker's log book, sampling valve, number of copies of delivery tickets, required data on delivery tickets, and the statements of certification are outlined in Article 1020-1 of the Specifications. These requirements apply to all asphalt materials; including prime coat, tack coat, and asphalt binders.

Article 1020-1 also provides that all asphalt transport tankers shall have a sampling valve in accordance with the recommendation of the Asphalt Institute and ASTM D140, or a comparable device acceptable to the Engineer.

The sampling device on the transport tanker shall be utilized to obtain the sample of asphalt material. Sample containers should be new and are available from the Materials & Tests Laboratory. Glass containers should not be used. The sample container should not be washed, rinsed out, or wiped off with oily cloths prior to use. The top of the container must fit securely. In obtaining a sample from the sampling valve, approximately 1 gallon of the asphalt material should be drawn from the valve and discarded for sampling purposes. The container should then be filled from the valve and the lid securely fastened to the container. Samples must not be transferred from one container to another. The sample should then be forwarded to the Materials & Tests Unit with the appropriate sample identification cards.

If the transport tanker does not have a sampling device, the Engineer should contact the Materials & Tests Unit concerning the acceptability of any other sampling device.

Article 1020-1 also outlines the information that is to be shown on delivery tickets for **all** asphalt materials. Also, included is an example statement of certification forms which must be included on the delivery ticket. Failure to include or sign the certifications will be cause to withhold use of the affected material until a sample can be taken and tested.

Occasionally, a Contractor may purchase asphalt material for one project and have it delivered directly to another project. If asphalt material arrives on a project with an incorrect project number shown on the delivery ticket, the ticket must be changed by the Contractor to show the correct project number before it can be accepted for use. The Technician should

indicate in "Remarks" on the Materials Received Report covering the material the project number that was originally shown on the ticket.

Asphalt materials received on one project and later transferred to another project should be handled in the normal manner for transferring materials from one project to another. Caution should be exercised to prevent the mixing of various grades or types of asphalt materials and/or contamination of the material.

## 620-3 GENERAL REQUIREMENTS

NCDOT specifications require that silicone be added to asphalt binder used in **all surface course mixtures**, both virgin and recycled, as well as open-graded asphalt friction courses. Silicone is used in asphalt because of its foam suppressing capabilities and also because it helps to minimize the tearing and pulling of an asphalt mix behind the paving machine. The silicone is added at the rate of 1 ounce per 2500 gallons of asphalt binder and may be added either at the asphalt plant or at the supplier's terminal when so noted on the delivery ticket. The brand used must have been previously approved by the Department and shown on the approved list maintained on the M&T Unit's web page. The silicone is normally poured into the top of either the asphalt delivery tanker or the storage tank at the plant site. **If poured into the binder storage tank, it must be allowed to adequately circulate throughout the asphalt binder storage tank prior to use of the asphalt binder**.

**All** Superpave asphalt mixes require an anti-strip additive be added to the asphalt binder in accordance with Sub-Article 610-3(B). When a chemical additive is used, a minimum of 0.25% by weight of binder in the mix shall be added. When hydrated lime is used, add it at a rate of not less than 1.0% by weight of the total dry aggregate in the mix. The type and amount of anti-strip additive to be used will be shown on the job mix formula. The equipment used to incorporate the anti-strip additive into the binder shall comply with Sub-Article 610-5(B)(2). See Section 610 of this manual and the current HMA/QMS Manual for more detail requirements of incorporating the anti-strip additive into the mixes and specific equipment requirements.

## 620-4 MEASUREMENT AND PAYMENT

Article 620-4 of the Specifications addresses the Measurement and Payment for Asphalt Binder, including the provisions for adjusting the contract unit price for asphalt binder due to market fluctuations. Payment will not be based on a specific grade for binder. Instead, the payments are based on Asphalt Binder for Plant Mix or Polymer Modified Asphalt Binder for Plant Mix.

The quantity of binder to be measured and paid for will be the theoretical number of tons required on the applicable e job mix formula based on the actual mix tonnage of that specific job mix formula. For example if a JMF specified a total of 5.0 % PG 64-22, the actual mix tonnage of that JMF produced would be multiplied by 0.05 (5.0%) to determine the pay quantity of asphalt binder. When recycled mixes are used, the theoretical number of tons calculated shall include the new added asphalt binder, the salvaged asphalt binder from the reclaimed asphalt pavement (RAP), and/or salvaged asphalt binder from reclaimed asphalt shingles (RAS).

The cost of the anti-strip additive incorporated into the binder will be considered incidental to the cost of the binder and there will be no direct payment for it. When silicone is added to the binder in surface mixes, it will also be considered incidental and there shall be no direct payment for it.

This Section also addresses a provision for adjusting the contract unit price of the binder when there are fluctuations in the average market prices. The specifications cover this procedure in detail and should be referred to when making these adjustments.

# SECTION 650
# OPEN-GRADED ASPHALT FRICTION COURSE, TYPES FC-1, FC-1 MODIFIED, AND FC-2 MODIFIED

## 650-1 DESCRIPTION

This section covers 3 types of friction course mixes. Friction course mixes are open-graded type mixes as compared to the typical dense graded plant mixes; therefore, the name open-graded asphalt friction course. Unlike dense-graded mixes, an open-graded mixture is designed to be water permeable. Open-graded mixes use only crushed stone (or gravel) and a small percentage of manufactured sands.

The primary purpose of friction course mixes is to provide a more skid resistant pavement surface by removing the surface water and draining it out to the pavement edges. An additional benefit is that spray due to traffic is significantly reduced.

All 3 of these friction course mixes are a combination of coarse aggregate(s) and binder with some aggregate screenings added as needed. In addition an anti-strip additive is added to the binder and a fiber-stabilizing agent is added to the mixture. The FC-1 Type mix is basically a combination of 78M aggregate and PG 64-22 binder with some aggregate screenings added if needed. The FC-1 Modified mix is the same mix except that a PG 76-22 binder is used. The FC-2 Modified mix normally incorporates some No. 67 aggregate as well as the 78M and possibly screenings and uses the PG 76-22 binder.

Normal usage of the FC-1 Modified and FC-2 Modified will be on the travel lanes of moderate to heavily traveled pavements. The FC-1 Modified may be used on lighter traveled pavements as well. The FC-1 mix will normally be used on very light traffic roads and in situations where small quantities of friction course mix are needed, such as in curves where better skid resistance is the objective.

The FC-1 and FC-1 Modified is normally applied at a rate of approximately 70-75 pounds per square yard (typically a 5/8” thick layer) and the FC-2 Modified at an approximate rate of 90 pounds per square yard (3/4” thick layer).

## 650-2 MATERIALS

Section 1020-2 of the specifications covers the requirements for the asphalt binders. There are 2 basic grades of binders used in most of the Open-Graded Asphalt Friction Course mixes. These grades are PG 64-22 and PG 76-22.

Fiber additives are used to stabilize the asphalt film surrounding the aggregate particles in order to reduce drain-down of the asphalt binder. Similar to flour used with broth to make thicker gravy, fiber additives are used to increase the viscosity of the asphalt binder so that it will not drip off of the aggregate particles or pool at the bottom at the bottom of the layer.

## 650-5 CONSTRUCTION METHODS

Weather, temperature, and seasonal limitations must be met before producing open-graded asphalt friction course asphalt mixtures. The seasonal limitations for OGAFC are longer than for those established for dense graded mixtures. The road surface temperature requirements are also higher for the modified mixes.

Asphalt binder grade, PG 64-22 should be used as the tack coat material for OGAFC. This straight asphalt cement application should be placed at a rate of 0.06 to 0.08 gallons per square yard.

A materials transfer vehicle should be used whenever placing Type FC-1 modified or Type FC-2 Modified friction course on full width travel lanes, shoulders, collector lanes, ramps, and loops.

## 650-6 QUALITY MANAGEMENT SYSTEM

There is a project special provision for the QMS requirements on open-graded asphalt friction course mixes. This provision should be included in the contract. For the most current QMS provision covering OGAFC, contact the Contract Standards and Development Unit by phone at (919) 707-6900.

# SECTION 652
# PERMEABLE ASPHALT DRAINAGE COURSE
# TYPES P-78M AND P-57

## 652-1 DESCRIPTION

The typical application for Permeable Asphalt Drainage Course (PADC) is under Portland Cement Concrete Pavement. The drainage course provides a means for water to effectively travel to a shoulder drain.

## 652-2 MATERIALS

Sections 1012 and 1020 of the specifications cover the requirements for the aggregates and asphalt binders used for PADC.

## 652-3 COMPOSITION OF MIXTURE

The design requirements and criteria for the various Permeable Asphalt Drainage Course mix types are given in Table 652-1.

## 652-4 CONSTRUCTION METHODS

The Permeable Asphalt Drainage Course should only be compacted to a degree acceptable to the Engineer. Typically the PADC is rolled once or twice to set the material in place. Do not compact the drainage layer to the extent that it is not free draining or that the aggregate is crushed.

No construction traffic should be allowed to travel on any PADC. Only equipment necessary to place the next layer of pavement will be allowed on the drainage layer.

The seasonal limitations for PADC are similar to dense graded mixtures in that they should either be covered with the next layer of pavement within the same calendar year or within 15 days of placement if placed in January or February. A sand seal should not be placed on a PADC layer as this may affect its draining capabilities. If the PADC cannot be covered within these time frames, it should not be placed.

### 652-5 Quality Management System

There is a project special provision for the QMS requirements on permeable asphalt drainage course mixes. This provision should be included in the contract. For the most current QMS provision covering PADC access the Pavement Construction Section's web page at https://connect.ncdot.gov/projects/construction/Pages/Pavement-Construction.aspx or call (919) 707-2400.

## SECTION 660
## ASPHALT SURFACE TREATMENT

### 660-1 DESCRIPTION

This section of the Specifications covers all types of asphalt surface treatments (AST). Surface treatments consist of one or more applications of an asphalt material and one or more applications of aggregate cover material on a prepared surface.

Surface treatment provides a waterproof cover over its base and provides resistance to the abrasion of traffic. It is not intended in itself to greatly increase the strength of the base or pavement.

Surface treatments have many functions. They will provide long-lasting economical surfaces for granular base roads having light and medium traffic volumes. They will help prevent surface water from penetrating granular bases and old pavements that have become weathered or cracked. Surface treatments will plug voids and also coat and bond loose mineral aggregate particles. They will renew a surface and restore skid resistance to traffic on pavements in which the surface aggregates have become polished. They are sometimes used to provide delineation and rumble effect between mainline pavements and shoulder pavements. Mat coats may be used as a crack absorbing layer between an existing concrete pavement and asphalt overlay.

### 660-2 MATERIALS

The Technician should always refer to the Special Provisions in the contract since in some instances the specific grade of asphalt and/or size of aggregate and application rates will be specified. When the grade of asphalt material and/or aggregate to be used is not specified in the Special Provisions, this article gives a list of materials from which the Contractor may select with certain restrictions. See Sections 1012 and 1020 of the Materials Division of the Specifications for aggregate and binder requirements (see also Table 660-1 in the Standard Specifications).

Clean aggregate is extremely important in surface treatment work. If the aggregate particles are dusty or coated with silt or clay, the asphalt may not bond, since the dust produces a film which prevents adhesion to the aggregate. See the remarks and footnotes concerning AST aggregates in Table 1005-l of the Standard Specifications.

## 660-3 WEATHER AND SEASONAL LIMITATIONS

Weather conditions are critical to the successful placement of surface treatments. Hot and dry weather is best for the application of surface treatments. The surface of the base must be dry in order to obtain satisfactory results from the application of the asphalt material. The combination of water or wet surface, fresh surface treatment, and traffic will result in the loss of the cover aggregate.

Should the Contractor feel that there are extenuating circumstances and justifications to waive the seasonal restrictions, he should be advised to make written request to the Engineer giving such circumstances and justifications. Upon receipt of any such request, the Engineer should forward the Contractor's request along with his own recommendations and reasons for such recommendations to the Division Engineer.

## 660-4 SURFACE PREPARATION

The surface to be treated must be clean of all foreign and deleterious matter and must be dry before the asphalt material is applied. This is essential to the successful performance of surface treatment. The surface is normally cleaned by the use of a rotary broom and a certain amount of handwork may be necessary in order to properly clean a base or surface. Any damaged or defective areas in a primed surface should be repaired prior to the application of the asphalt material.

## 660-5 ACCEPTANCE OF ASPHALT MATERIALS

The Department reserves the right to sample and test any asphalt material shipment regardless of whether a certification is furnished. If the material appears questionable, it should be sampled. The asphalt emulsions should not be diluted or mixed with water, solvents, or other materials prior to application.

## 660-6 APPLICATION EQUIPMENT

An asphalt distributor is typically used to apply the asphalt emulsion to the existing surface prior to the application of the aggregate. Refer to Article 600-5 of the Specifications and this Manual for the requirements of the distributor.

A self-propelled, pneumatic-tired aggregate spreader is used in conjunction with the distributor on surface treatments. A spreader in good working condition and properly operated will conserve aggregate and produce a uniform spread. The self-propelled spreader provides a uniform and continuous application of cover aggregate and is able to keep up with the asphalt distributor. Aggregate trucks dump their load into a receiving hopper in the rear of the spreader and are pulled along by the spreader as it moves forward. Belt conveyors carry the aggregate to the front of the spreader machine where it is dropped into a spreading hopper.

The spreader must be capable of spreading the aggregate over the full lane width of the applied asphalt material in a single pass.

## 660-7 APPLICATION OF ASPHALT MATERIALS

When the grade of asphalt material is not specified in the Special Provisions, the Contractor may select any grade of asphalt shown in Table 660-1 for the type of treatment being constructed. The rates of application are based on asphalt material at the application temperatures specified.

The Technician should make certain that the asphalt material is being applied uniformly and at the temperature and within the rates specified in Table 660-1. A lack of adequate asphalt material in surface treated pavements, including paved shoulder construction, contributes greatly to the loss of the cover aggregate when exposed to traffic. The correct grade, amount and temperature of the asphalt material will when being applied be fluid enough to spray properly and cover the surface uniformly but will be viscous enough to remain in a uniform layer. It also will not puddle in depressions or run off the crown and after rolling and curing will hold the aggregate tightly to the road surface to prevent dislodging by traffic and will not bleed or strip with changing weather conditions.

## 660-8 APPLICATION OF AGGREGATES

This article of the Specifications gives the aggregate size and application rate for each type mat or seal of coat (see Table 660-1). This article also gives the Engineer the authority to require the Contractor to weigh a sufficient number of loads of aggregate prior to spreading to verify that the rate of application is within the required limits indicated in this table or the Special Provisions.

The cover aggregate shall be spread uniformly, immediately after the asphalt application. This is of utmost importance in obtaining adequate retention of the aggregate when exposed to traffic. The aggregate must be applied before the asphalt begins to "break." The aggregate cannot be applied too quickly but can most definitely be applied too late. This requires enough trucks loaded with the aggregate to be standing by and careful planning and coordination by the Contractor so that there will be no delays once the asphalt is applied. Careful timing and coordination are absolutely necessary to produce the desired results.

Immediately after application, the aggregate should be set in place by rolling to produce a smooth, tight surface of even texture. As soon as the asphalt has a definite set or hardening, rolling should be discontinued so that the roller will not break the bond between the surface and the aggregate.

## 660-9 CONSTRUCTION METHODS

### (A) ASPHALT MAT COAT

The surface upon which mat coat or seal coat is to be applied must be clean. Cleaning is normally accomplished by the use of a power rotary broom. It may sometimes be necessary to utilize blowers and flushing equipment to clean a surface prior to the asphalt application. The surface should also be dry prior to the application of asphalt material.

It is a requirement of this article of the Specifications that a string line be placed by the Contractor and used as a guide for application equipment unless otherwise permitted by the Engineer.

The nozzles of the spray bar should be kept clean and properly adjusted at all times. If one or more nozzles should become blocked during application, the distributor must be stopped and the nozzles cleaned out.

All mat coat and seal coat shall be placed in full lane widths unless otherwise permitted by the Engineer. When asphalt materials are applied for less than the full width of the treatment, a suitable longitudinal joint should be provided. To prevent aggregate from building up on the longitudinal joint, the edge of the aggregate spread should coincide with the edge of the full thickness of applied asphalt. This allows overlapping of the partial thickness of applied asphalt when the adjacent width is sprayed with asphalt. The partial thickness is a result of the outside nozzle spray being only partially overlapped. The width of the asphalt strip left exposed varies depending upon the nozzle spacing and the lap pattern used. If possible, the longitudinal joint should be along the centerline of the pavement being treated. An established line ensures a straight longitudinal joint. Anticipated aggregate needed for the intended treated area should be on hand before starting the asphalt application. When the distributor moves forward to spray asphalt, the aggregate spreader should follow immediately behind. The sprayed asphalt should be covered with aggregate as soon as possible but in no case should more than 5 minutes elapse before coverage begins.

Rolling must be done immediately after the aggregate has been uniformly spread. Rolling seats the aggregate in the asphalt and thus promotes the bond necessary to resist traffic stresses.

This article of the Specifications requires the initial coverage to be done with a steel wheel roller. The Technician should closely observe the beginning of this initial coverage to determine if the aggregate is being crushed appreciably. If crushing is occurring, the use of a lighter steel wheel roller should be required. The rolling is then completed with a pneumatic-tired roller. The coat should be rolled until the aggregate is properly seated. As soon as the asphalt has a definite set or hardening, rolling should be discontinued to prevent the bond between the surface and the aggregate being broken by the roller. Rolling normally begins at the outer edge of the surface treatment and proceeds in a longitudinal direction working towards the center of the road. Each trip with the roller should overlap the previous trip by about 1/2 the total width of the roller wheels. The Engineer may direct other rolling patterns.

In beginning the distribution of each load of asphalt material, the proper joint shall be made with the preceding application. Building paper or other suitable material shall be spread at all starting points in order that the distributor nozzles may be operating at full force when the asphalt application begins and ends. This same procedure should be followed at intersections and junctions with other pavements. The paper should be removed immediately after use and properly disposed of by the Contractor. Excess asphalt material should be removed or corrected in a satisfactory manner. Irregular areas which cannot be covered with asphalt material directly from the distributor spray bars shall be covered by means of a hand hose equipped with a nozzle.

In applying asphalt material adjacent to structures, the Contractor should use effective means of protecting the structure from spray by asphalt material.

This article of the Specifications states that traffic may be permitted on the mat coat immediately after the rolling is complete. The excess aggregate should be broomed off prior to placement of traffic to prevent damage to vehicles from loose aggregates. Speed of the traffic should be restricted to 25 miles per hour or less for several hours.

## (B) ASPHALT SEAL COAT

This article of the Specifications specifies the construction methods that are to be used in the construction of all seal coats.

The Engineer should refer to the contract to determine the size of aggregate and the type of seal coat that is required by the contract for each section to be sealed.

The seal coat aggregates should have been tested and approved prior to their incorporation into the seal coat. They should be drained of all free moisture. It is important that the aggregate be clean. If aggregates are dusty or coated with silt or clay, a film is present which will prevent proper asphalt adhesion. Good adhesion between aggregate and asphalt and retention of this adhesion are essential to surface treatment success. Best adhesion is obtained when aggregates are clean and reasonably dry. Some moisture can be tolerated in warm, dry weather that promotes rapid drying.

The width of seal coat construction, joint construction, and application of asphalt and aggregate shall be as explained previously in Article 660-9(A) of the Specifications and this Manual.

Rolling for all seal coats shall be accomplished as described in the following paragraph, except that only the pneumatic-tired roller shall be used on sand seal.

Rolling shall be done immediately after the aggregate has been uniformly spread. Initial rolling shall consist of one complete coverage with a steel wheel roller after which pneumatic-tired rollers shall be used. Rolling shall continue until the aggregate is thoroughly keyed into the asphalt. A final coverage with the steel wheel roller may be required to provide a satisfactory finished surface. The use of rollers that result in excessive crushing of the aggregate will not be permitted. The rollers shall be designed to prevent picking up the material. The use of

combination steel wheel and pneumatic- tired rollers will not be permitted. Two individual rollers shall be used.

When directed by the Engineer, the Contractor shall apply blotting sand in accordance with the provisions of Section 818.

**1) Straight Seal**

Straight seal is a term used to describe a treatment that consists of one application of liquid asphalt and one application of aggregate. The thickness of the treatment is about the same as the nominal maximum size of aggregate particles. It is essential that the aggregate is clean and that it be spread before the liquid asphalt begins to break or set. If the aggregate is excessively damp, no retention will develop until it dries.

Excess aggregate should be broomed from the surface immediately after the initial set of the asphalt and before traffic is placed upon the seal if possible. Brooming is usually best accomplished early in the day when the pavement surface and the asphalt binder are cool.

**2) Split Seal**

Split seal is a double application of asphalt and aggregate followed by rolling, as noted previously.

Immediately after the first application of seal aggregate has been made uniform, the remainder of the required amount of asphalt material and seal coat aggregate shall be applied and the seal coat shall be rolled as previously described.

**3) Triple Seal**

Triple seal is a triple application of asphalt and aggregate followed by rolling as noted previously.

**4) Slurry Seal**

Slurry Seal is a mixture (slurry) of aggregates and asphalt emulsion that is applied by a spreader in a single thin layer.

**5) Sand Seal**

The full-required amount of asphalt material shall be placed in one application and immediately covered with the seal coat aggregate. The full required amount of aggregate shall be uniformly spread in one application and all non-uniform areas shall be corrected prior to rolling.

Immediately after the aggregate has been uniformly spread, rolling shall be done as previously described.

When directed by the Engineer, excess aggregate material shall be broomed from the surface of the seal coat.

When the sand seal is to be constructed for temporary sealing purposes only and will not be utilized by traffic, other grades of asphalt material meeting the requirements of Articles 1020-6 or 1020-7 may be utilized in lieu of the grade of asphalt required by Table 660-l when approved by the Engineer.

### (C) ASPHALT MAT AND SEAL

The mat coat shall be constructed in accordance with Subarticle 660-9(A) using the size aggregate required by the contract.

The seal coat shall be constructed in accordance with Subarticle 660-9(B) using the type seal required by the Project Special Provisions.

### (D) CAPE SEAL

The seal coat shall be constructed in accordance with Subarticle 660-9(B) using the size aggregate required by the contract.

The slurry seal shall be constructed in accordance with Subarticle 660-9(B)(4) using the type slurry seal required by the Project Special Provisions.

## 660-10 MAINTENANCE AND PROTECTION

The Contractor is responsible for the maintenance and protection of surface treatment until such time as the Department accepts the work for maintenance. He should make all necessary repairs immediately to the satisfaction and under the supervision of the Engineer.

## 660-11 MEASUREMENT AND PAYMENT

Surface treatments will be paid on a square yardage basis. In measuring the quantity, the number of square yards will be determined using the actual length constructed and the width required by the project plan details or as directed by the Engineer.

A replacement of satisfactory completed surface treatments made necessary by defects in the subgrade or base which were constructed by others will be paid for under this article.

No reduction in compensation will be made when the Engineer directs the application rates of asphalt material to be less than the minimum indicated in Table 660-1 of the Specifications.

Blotting sand will be paid for as provided in Article 818-4 of the Specifications. It should be noted that additional payment would not be made for blotting sand where the blotting material is a component of any Asphalt Seal Coat, Asphalt Mat and Seal, or Cape Seal.

**TECHNICIAN'S CHECKLIST**
**SECTION 660**
**ASPHALT SURFACE TREATMENT**

1) Study the Specifications, plans, and Special Provisions.
2) Refer to the Special Provisions to determine whether a specific grade of asphalt and/or aggregate and application rate are specified. When the grade of asphalt is not specified the Contractor may use any grade of asphalt shown in Table 660-1 for the type of treatment.
3) Ensure that the aggregate used is clean.
4) Ensure the surface of the base material is dry in order to obtain satisfactory results from the application of the asphalt material.
5) Ensure all damaged or defective areas have been repaired prior to the application of asphalt.
6) If the asphalt material appears questionable, take a sample.
7) Ensure that the asphalt material is being applied uniformly and at the temperature rates specified in Table 660-1.
8) Ensure the cover aggregates are spread uniformly, immediately after the asphalt application. The aggregate must be applied before the asphalt begins to "break".
9) Ensure a string line has been placed to guide the application equipment unless otherwise permitted.
10) Verify during the initial coverage that the aggregate is not being crushed appreciably. If crushing is occurring, use a lighter steel wheel roller.
11) Ensure paper has been placed across the surface at all starting points to ensure the distributor is operating at full force when the application begins and ends.
12) Ensure the aggregates have been tested and approved prior to their incorporation into the seal coat.
13) Ensure that all pay items as defined in the Specifications (Section 660-11) are measured and properly recorded in appropriate pay record books.

## SECTION 661
## ULTRA-THIN BONDED WEARING COURSE

### 661-1 DESCRIPTION

Ultra-Thin Bonded Wearing Course (UTBWC) is a coarsely graded hot mix asphalt (HMA) placed in a thin layer onto a warm Polymer-Modified Emulsion Membrane (PMEM). The PMEM is sprayed onto the existing pavement immediately before applying the hot mix asphalt. The UTBWC is placed in either ¼", $^3/_8$", or ½" compacted thickness; therefore, is more of a surface treatment than a normal HMA, in that the UTBWC does not provide much structural value. This treatment does offer a very durable surface that will protect the overlaid pavement for several years and is also a good inhibitor for reflective cracking.

### 661-2 MATERIALS

Division 10 of the specifications covers most of the basic requirements for the different materials used in the Ultra-Thin Bonded Wearing Course. However, Tables 661-1 and 661-2 contain requirements which require the aggregates used to be of higher quality than most aggregates used in plant mixes. These requirements help to assure a more durable, skid resistant pavement. Table 661-3 contains the material requirements for the polymer modified emulsion membrane.

The plant mix is normally comprised of a coarse aggregate (usually an intermediate size stone such as 78M), a fine aggregate (such as screenings), a PG 70-28 asphalt binder, an anti-strip additive, and possibly a mineral filler, if needed. The specific requirements for the PG 70-28 binder are covered in Section 661-2 (E) of the specifications. The polymer modified emulsion membrane is an emulsified liquid asphalt which has been modified by incorporating a polymer into the binder. This emulsion is sprayed onto the existing pavement surface to provide a water impermeable seal and to promote a bond with the new plant mix.

The Contractor must submit a proposed mix design and JMF for the hot mix asphalt (HMA) to M&T Asphalt Design Engineer at least 10 days prior to start up. Mix Design Procedures may be obtained from the M&T Asphalt Design Engineer. If approved, the JMF will be issued by Pavement Construction Engineer. The approved mix design and JMF must be at the asphalt plant prior to beginning work.

There are three types of asphalt mixes used as Ultra-Thin Bonded Wearing Courses. Next is a brief description of these mix types with rates of application for both the mixes and the polymer modified emulsion.

**Mix Types:**

1. Type A (Coarsest – 100% Passing ¾")
2. Type B (Mid-Size – 100% Passing ½")
3. Type C (Finest Size – 100% Passing $^3/_8$")

**Rates of Application**:

1. Mix
   a. Type A = 90 lbs./yd$^2$ (+/- ¾" uncompacted)
   b. Type B = 70 lbs./yd$^2$ (+/- $^5/_8$" uncompacted)
   c. Type C = 50 lbs./yd$^2$ (+/- ½" uncompacted)
2. Polymer-modified emulsion = Typically in range of 0.15 to 0.25 gals/yd$^2$ but exact rate will be under "Comments" on JMF.

## 661-4 CONSTRUCTION METHODS

### (A) EQUIPMENT

The basic equipment required is the paving machine and the roller(s) used for compaction. The specific requirements for these are covered in Section 661-3 but the following is a brief description of the paver and roller.

The paving machine generally functions the same as a traditional paver except that it must be capable of storing and spraying the PMEM onto the existing pavement immediately prior to the placement of the mix. It is required to have an adjustable full width screed with crown adjustments. It also must have electronic screed controls with either a 30-ft. minimum length mobile grade reference system or a 24-ft. non-contacting laser or sonar type ski.

Normally, asphalt rollers are used to compact the plant mix. A minimum of one steel double drum asphalt roller with a minimum weight of 10 tons is required.

### (B) SURFACE PREPARATION

This section of the specifications is self-explanatory.

### (C) APPLICATION OF UTBWC

The plant mixed HMA (either Type A, B, or C) is delivered by haul trucks to the paver at the project site. The paver applies a spray coverage of PMEM at the rate specified on JMF and in the temperature range of 140º-180ºF. The paver spreads and screeds the HMA at the rate specified for the particular mix type within three seconds of the PMEM application. The mix temperature during the spreading and screeding process should generally be in the 300º-330ºF range. When checked in the haul truck on the roadway, the mix temperature should be within +15ºF to -25ºF of the JMF temperature.

### (D) COMPACTION

Asphalt rollers compact the mix with a minimum of two passes before the mix temperature falls below 185ºF. There is no density requirement for the UTBWC.

### (E) QUALITY MANAGEMENT SYSTEM FOR ASPHALT PAVEMENTS

The contract should contain a Project Special Provision titled **"Quality Management System for Asphalt Pavements: (OGAFC, PADC, and ULTRATHIN HMA Version)."** This Project Special Provision will contain all QMS plant mix and roadway testing requirements but below is a brief description of those requirements.

**Plant Mix Testing**

1. HMA Temperature: +/- 15ºF of JMF temperature
2. Binder content and gradation tests (1 sample per 500 tons Ultra-thin HMA)
3. Draindown test (Beginning production & weekly thereafter)
4. TSR: Compacted to 100 gyrations (Beginning production)

**Roadway Testing**

1. HMA Temperature: + 15˚F to - 25˚F of JMF temperature
2. No Density Requirements (Minimum 2 passes with steel wheel roller)

For the most current Ultra-Thin QMS provision, access the Pavement Construction Section's web page at: https://connect.ncdot.gov/projects/construction/Pages/Pavement-Construction.aspx

## 661-6 MEASUREMENT AND PAYMENT

The method of measurement and basis of payment for the applicable pay items related to the Ultra-Thin Bonded Wearing Course are as follows:

**Ultra-Thin HMA**: Actual number of tons documented on weigh tickets.

**Application of Ultra-Thin HMA**: Measured square yards of application (actual length times contract or directed width).

**Binder for Plant Mix, PG 70-28**: Theoretical number of tons of binder.

1. Determined by multiplying JMF binder percentage times actual number of tons of Ultra-Thin HMA.
2. Binder price adjustments based on PG 64-22 regardless of grade used.

**TECHNICIAN'S CHECKLIST**
**SECTION 661**
**ULTRA-THIN BONDED WEARING COURSE**

1) Study the Specifications, plans, and Special Provisions.
2) Refer to the Special Provisions to determine the testing requirement for the plant mixed HMA.
3) Ensure the paver has an adjustable full width screed with crown adjustments. The paver should also have electronic screed controls with either a 30-foot minimum mobile grade reference system or a 24-foot non-contacting laser or sonic type ski.
4) Ensure that at least one steel drum asphalt roller weighing a minimum of 10 tons is used.
5) Ensure all damaged or defective areas have been repaired prior to the application of asphalt.
6) Ensure that manhole covers, drains, grates, catch basins and other utilities are covered in plastic to protect them from the overlay.
7) Ensure all joints and pavement cracks greater than ¼ inch wide are filled. Overbanding should not be allowed.
8) Ensure surface irregularities greater than 1 inch deep are filled with material approved before placement of the UTBWC.
9) Ensure the pavement surface is thoroughly cleaned.
10) Ensure that the asphalt material is being applied uniformly and within +15°F to –25°F of the JMF temperature.
11) Ensure the rollers compact the mix with at least two passes before the mix temperature falls below 185°F.
12) Ensure that all pay items as defined in the Specifications (Section 661-4) are measured and properly recorded in appropriate pay record books.

## SECTION 663
## HOT IN-PLACE RECYCLED ASPHALT CONCRETE

### 663-1 DESCRIPTION

Hot In-Place Recycling (HIR) of asphalt pavements is an on-site process wherein the existing pavement is preheated and softened using indirect heating units, milled, admixture and rejuvenator added as needed, remixed, replaced, and compacted in a single pass of the paving train equipment. HIR is intended to correct normal wear and environmental defects such as block or transverse cracking and oxidation. It is not intended to significantly increase the structural capacity of a pavement and therefore, is not intended to be used as an alternate for all resurfacing situations.

Some factors to consider when selecting a project for HIR:

- Minimum of 3-4 inches of existing pavement.
- Relatively uniform without excessive patching.
- Does not exhibit excessive crack sealant (causes excessive smoke during construction).
- Stable base with adequate strength to carry anticipated equipment and traffic.
- No geotextile interlayers within top 2 inches.
- Adequate access to an asphalt plant for admix.
- Adequate space to park extensive paving train overnight and when not operating.

Quality Control and Quality Assurance and the required testing for acceptance of the HIR mixture will be performed in accordance with the Project Special Provision "Quality Management System For Asphalt Pavements (Hot In-Place Recycled Asphalt Concrete)", included in the contract.

### 663-2 MATERIALS

See Table 663-2 for typically used HIR mix types and design criteria. Select the mix type for the anticipated traffic level, keeping in mind that the finished mix can be made coarser (with admix) but not finer than the existing mix. In addition, consideration must be given to whether the recycled layer will be the final wearing surface or if it will be overlayed with additional HMA.

### (A) HOT MIX ADMIXTURE

Asphalt admix may or may not be needed depending on the objectives of the project and properties of the existing mix/pavement. Asphalt admixture, if required, is normally not a specified mix type, even though it may be of the same gradation as a particular mix type. The binder grade used in all admix will be **PG 64-22**, regardless of the HIR mix type specified. Admix can be used to modify mix properties (gradation, binder content, skid resistance, mix stability, voids properties, and layer thickness). Typically, the admix amount (rate) ranges between 30 and 50 lbs./SY. If to be used, the exact rate of admix application should be specified in the pavement schedule for the typical section in the plans and also used in computing contract admix quantities.

### (B) ASPHALT REJUVENATING AGENT

Asphalt Rejuvenating Agent is added to the recycled mix to restore the properties of the aged and hardened binder in the existing pavement and the completed recycled pavement to the

desired properties that would be expected in a pavement composed of all new materials. There are several ways of determining the amount needed. Currently, 0.3 – 0.4% of the total binder required for the mix is used at the mix design stage and then the binder in the field produced mix is extracted and tested for viscosity and/or penetration criteria (See Table 663-2). The percentage may then be adjusted based on test results.

## 663-3 COMPOSITION OF MIXTURE (MIX DESIGN/ JOB MIX FORMULA)

### (A) MIX DESIGN – GENERAL

The Contractor must sample the existing roadway, design and submit a proposed mix design and JMF for both the HIR and Admixture (if applicable) and obtain approved JMFs prior to start up. See Article 663-3 of the Standard Specifications for more details. In addition, detailed information on computing blend ratios and other information are available from the Department's M&T Unit and from the Construction Unit.

**The HIR layer thickness indicated on the typical section is the compacted in-place thickness of the rejuvenated recycled mixture layer, including any admix, if required**. This compacted recycled layer thickness and the amount of admix to be added, if any, are used to compute the mix design blend ratio and other criteria and also for QMS thickness control during construction. The compacted layer depth, admix rate and other calculations are based on 110 Lbs./SY/inch of mix.

For Example: The typical section in the plans indicates a compacted layer depth of 2" using 40 Lbs./SY Admixture. The approximate blend ratio for mix design purposes is determined as follows:

2" @ 110 Lbs./SY/inch = 220 Lbs./SY (Total recycled compacted depth)
220 Lbs./SY – 40 Lbs. / SY Admix = 180 Lbs./SY RAP.
Blend Ratio = 180 ÷220 / 40 ÷220 = 82% RAP / 18% Virgin

The blend ratio of the completed mix in the above example would be approximately 82/18 RAP / VIRGIN for mix design and milling thickness determination.

### (B) MIX DESIGN CRITERIA

Aggregate Gradation and Mix Design Criteria for the various HIR mix types are included in Tables 663-1 and 663-2, respectfully (Also See Project Special Provisions).

### (C) JOB MIX FORMULA

A JMF will be issued for both the completed HIR mix and for the Admixture, if required. The admixture is for a specific Mix Design/JMF on a specific project or section of a project. Admixture JMFs cannot be utilized in a different mix design.

## 663-4 EQUIPMENT

Specific requirements for the various equipment units required in the HIR process are included in Article 663-4. Typical one-pass hot milling equipment is generally capable of heating and milling depths between 1 and 2 inches. The depth of heating and temperature achieved is significantly influenced by the existing pavement temperature, moisture content, wind, number of heating units, forward speed of operation and other factors. Care must be taken

to achieve the required depth of the recycled layer depth without fracturing the aggregate and/or overheating the pavement. Overheating not only damages the completed mix but also causes excessive smoke during the recycling process.

The Milling / Blending Unit requirements are described in detail in Subarticle 663-4(C). A modified paver screed is normally attached to the milling / blending unit and functions very much like a standard paver screed. Automatic screed controls are typically used unless waived by the Engineer. The Compaction Equipment used in the compaction process is the same as the standard equipment used on all HMA mixes.

## 663-5 CONSTRUCTION METHODS

**The HIR layer thickness indicated on the typical section is the compacted in-place thickness of the rejuvenated recycled mixture layer, including any admix, if required.** The actual milling depth of the existing pavement is determined from the compacted thickness and the admix rate given on the typical section (See Article 663-3(A) of this Manual).

For Example: The typical section in the plans indicates a compacted layer depth of 2" using 40 Lbs./SY Admixture. The approximate blend ratio for mix design purposes is shown on the JMF as 82% RAP / 18% Virgin. The actual depth of milling required to achieve 2" of compacted pavement is determined as follows:

2" @ 110 Lbs./SY/inch = 220 Lbs./SY (Total recycled compacted depth)
220 Lbs./SY – 40 Lbs. / SY Admix = 180 Lbs./SY RAP.
180 Lbs./SY ÷ 110 Lbs./SY = 1.64 inches or approximately 1 5/8 inches.

The actual milling depth milling will need to average approximately 1 5/8 inches with 40 Lbs./SY admix to achieve a compacted layer depth of 2 inches.

### Quality Management System for Hot In-Place Asphalt Pavements

The contract should contain a Project Special Provision titled "Quality Management System For Asphalt Pavements (Hot In-Place Recycled Asphalt Concrete)". This PSP will contain all QMS Hot In-Place Recycled Mix, Admixture (if required), Thickness, and Field Compaction Quality Management requirements. Below is a brief description of most of these requirements. These requirements and procedures are covered in detail in the specifications and QMS provisions.

### Hot In-Place Recycled Mix

1. Mix sampled from behind paver at roadway
2. Binder content and gradation tests (1 sample per 5000 linear feet)
3. Gmm, Gmb, VTM, VMA, $P_{0.075}$/Pbe, Gini
4. Penetration Test on recovered binder
5. Prepare Rut Test Specimens

**Hot Mix Asphalt Admixture (if required)**
1. Binder content and gradation tests (1 sample per 200 tons)

**Roadway Testing**
1. Depth of milling of existing pavement
2. HIR Mix Temperature behind paver: (235 - 325 ºF)
3. Thickness of completed compacted recycled pavement
4. Field compaction
5. Smoothness

For the most current Hot In-Place QMS Provisions, access the Pavement Construction Section's web page at:
https://connect.ncdot.gov/projects/construction/Pages/Pavement-Construction.aspx

## 663-6 MEASUREMENT AND PAYMENT

The method of measurement and basis of payment for the applicable pay items related to the Hot In-Place Recycled Asphalt Concrete are as follows:

Hot In-Place Recycled Asphalt Concrete, Type _____: Actual number of square yards completed and accepted.

Asphalt Rejuvenating Agent: Actual number of gallons metered and used on project.

**NOTE: This quantity is not the computed quantity from the JMF.**

Hot Mix Asphalt Admixture: Actual number of tons documented on weigh tickets.

Asphalt Binder for Plant Mix Admixture, Grade PG 64-22: Theoretical number of tons of binder based on JMF.

1. Determined by multiplying JMF binder percentage times actual number of tons of Hot Mix Asphalt Admixture.
2. Binder price adjustments based on PG 64-22 regardless of grade used.